Chapter 3. Existing Habitat Conditions and Status of Fish Populations

Introduction

This chapter describes streams identified as priorities for restoration by the U.S. Fish and Wildlife Service , California Department of Fish and Game, or CALFED. The Fish Passage Improvement Program identified priority projects to improve fish passage in these drainages. The priority fish passage improvement projects were identified according to FPIP criteria that include previous identification by state or federal agencies. See Chapter 2 for a discussion of these criteria. These descriptions of fish population and habitat conditions provide the supporting biological and habitat-quality information for the priority projects described in Chapter 4.

This information is essential in assessing the benefits of modifying an in-stream structure to provide fish better access to upstream habitat. These descriptions address geography, historical and current anadromous fish populations, numbers and types of impediments to migration, spawning and rearing habitat conditions for anadromous fish, the types and sources of habitat data, and a summary of recent fish passage and stream restoration projects on the stream.

Figures 21-24 identify program areas and priority project streams. Tables 3-2 – 3-8 summarize the types of data available for each stream in the program area such as anadromous fish surveys, gravel surveys, temperature data, whether they are perennial or seasonal, anadromous fish present, and what is known about fish passage conditions at structures. No information about fish passage conditions was available for tributary streams of the San Joaquin River.

Appendix B contains a bibliography of the literature cited in each of the stream summaries, organized by streams. An extensive online bibliography of reports and other documents about Chinook salmon in the Central Valley can be found at the Web site: http://swr.ucsd.edu/hcd/cvscb.htm.

Figure 21. Fish Passage Improvement Program Sacramento River and Tributaries

Figure 22. Fish Passage Improvement Program Lower Sacramento River and Delta Tributaries

Figure 23. Fish Passage Improvement Program San Joaquin River and Tributaries

Figure 24. Fish Passage Improvement Program Bay Area and Delta

Table 3-2. Sacramento River Matrix

Table 3-3. Sacramento River Passage Matrix

Table 3-4. Lower Sacramento River Matrix

Table 3-5. Lower Sacramento River Passage Matrix

Table 3-6. San Joaquin River Matrix

Table 3-7. San Joaquin Passage Matrix

Table 3-8. Bay Area River Matrix

Table 3-9. Bay Area Passage Matrix

Sacramento River and Tributaries

Battle Creek, Tehama County

Potential Impediments to Anadromous Fish Migration

The mainstem of Battle Creek has four structures that act as potential impediments to adult anadromous fish migration: the (1) CNFH barrier weir that diverts returning hatchery fish into the hatchery for broodstock collection each year from September through early March; (2) the CNFH Intake 3 diversion weir that diverts water for the hatchery; (3) the Orwick seasonal gravel diversion dam, which diverts up to 50 cfs into an irrigation canal near PG&E's Coleman Powerhouse; and (4) the tailrace from PG&E's Coleman Powerhouse, which has been known to attract adult Chinook salmon and steelhead into an area with little spawning habitat (USFWS 2001). In addition, all of the mentioned diversions are unscreened or have screens that do not meet DFG's criteria for proper fish passage of out-migrating juvenile fish.

CNFH, 6 miles upstream from the mouth of Battle Creek, is operated by the USFWS. The hatchery was built in 1942 to help preserve significant runs of Chinook salmon threatened by the loss of natural spawning areas after construction of Shasta Dam on the Sacramento River (USFWS 2001b).

In the mid-1990s, the fish ladders at Eagle Canyon on North Fork Battle Creek and PG&E's Coleman Dam on South Fork Battle Creek were intentionally closed primarily to manage populations of spring-run Chinook salmon and steelhead. Closing the ladders limited the amount of stream available for spring-run salmon and steelhead that passed the CNFH barrier weir, making it easier for fish to pair for spawning (DFG 1995), preventing entrainment into unscreened diversions, and preventing passage to habitat having insufficient flow. Recently, the fall and late-fall runs of Chinook salmon have been partially restricted to about 6 miles between the mouth of Battle Creek and the CNFH barrier weir.

North Fork Battle Creek has three dams: Wildcat Dam, Eagle Canyon Dam and North Battle Creek Dam, all of which are below a natural barrier to anadromous fish migration. These three structures divert water for hydroelectric power production. South Fork Battle Creek also has three hydroelectric diversions below the natural barrier to fish migration: South Diversion Dam, Inskip Dam, and Coleman Dam. South Fork Battle Creek has two tributaries, Ripley Creek and Soap Creek that are navigable by anadromous fish. There is one diversion on each of the tributaries.

General Description

Battle Creek originates at an elevation of more than 7,000 feet on the western slope of the Cascade Range in Lassen National Forest. It flows easterly 60 miles to its confluence with the Sacramento River at River Mile 271. There are two main branches, the north and south forks, which converge about 12 miles above the Sacramento River confluence. Battle Creek's drainage area is 360 square miles. The monthly mean flow ranges from 265 cfs to 766 cfs with a median flow of 516 cfs. The total storage capacity for all the reservoirs in the watershed is 1,502 acre-feet (USFWS 2001a).

Fish Populations

Battle Creek is one of the most important Chinook salmon spawning streams in the Central Valley. Historically, the creek supported self-sustaining populations of all four runs of Chinook salmon, as well as steelhead trout. It has been recognized that Battle Creek may be the only stream besides the Sacramento River that can sustain all five Central Valley salmonid runs (NMFS et al. 1999). Before hydroelectric development, about 53 miles of the creek were accessible to these species. Today, Coleman National Fish Hatchery (CNFH) and closed fish ladders at PG&E's Coleman and Eagle Canyon dams control the amount of creek that is accessible to anadromous species. The upstream ladder in the barrier weir at CNFH is closed September through early March and the fish are held in the creek below the hatchery, although some fish can pass over the weir at flows greater than 350 cfs (USFWS 2001b). The fall and late-fall salmon are counted at CNFH.

Since 1952, DFG has used carcass counts to estimate fall-run Chinook salmon populations. All available spawning habitat (about 4 miles), which is utilized by fall-run Chinook salmon below the hatchery, is surveyed to count spawners. Fall-run salmon populations have ranged from a high of 92,949 in 1999 to a low of 1,770 in 1978. (Grandtab, DFG, Red Bluff Office, contact Colleen Harvey, 2000). From 1953 to 1967, the total average run was 17,000 adults (UFWS 1995).

The U.S. Fish and Wildlife Service has conducted fish counts at CNFH for all four runs of Chinook salmon and for steelhead in Battle Creek since 1995. Between 1995 and 1997, USFWS generated partial estimates for spring-run using a video camera in the fish ladder at the CNFH barrier weir. These partial estimates indicate Battle Creek has a run of 50 to 100 adult spring-run Chinook salmon (USFWS 1996).

In 1997, the winter-run Chinook propagation program was moved from CNFH to Livingston Stone National Fish Hatchery, to promote escapement to the mainstem Sacramento River (USFWS 2001b). However, monitoring efforts showed that three natural-origin, winter-run Chinook migrated past the CNFH barrier weir in 2000 (USFWS 2001b).

Steelhead trout have been reported in Battle Creek, but surveys for spawning adults have not occurred for several years. Thus, little is known about the size of the naturally spawning steelhead population. However, natural-origin adult steelhead returning to Battle Creek are integrated with hatchery-origin steelhead for an artificial propagation program at CNFH (USFWS 2000). Steelhead propagated at CNFH are considered part of the threatened Central Valley steelhead ESU (see Chapter 2) and excess hatchery-origin steelhead returning to CNFH are passed above the CNFH barrier weir, allowing them to spawn in Battle Creek (USFWS 2000).

Water Quality

Battle Creek water is generally high quality because of the many cold springs that feed into it and because it receives significant snowmelt during the spring and summer. CNFH uses three water source diversions to supply its operations. The primary water supply for CNFH is taken from the Coleman Powerhouse tailrace and originates from South Fork Battle Creek, but contains some north fork water because of interbasin transfers. There may be some water temperature effect resulting from this diversion.

The CNFH barrier weir limits the migration of fall- and late fall-run salmon past the hatchery because of concerns of introducing fish diseases into the hatchery water supply and to prevent fall-run salmon from hybridizing with threatened spring-run salmon. However, an ozone water treatment system, constructed in 1999 and being tested at CNFH, should significantly reduce the problem of fish pathogens at CNFH (USFWS 2001b).

In 2000-2001, DWR monitored nutrients in Battle Creek above and below the CNFH barrier weir to determine whether nutrient levels were correlated with the presence of fall-run Chinook carcasses in Battle Creek. Nutrients including dissolved ammonia, dissolved orthophosphate, total phosphorus, and dissolved nitrates plus nitrites were sampled weekly beginning in September 2000, before the onset of fall-run Chinook spawning in lower Battle Creek, and continuing until 6 Jan 2001, after spawning had ceased. A strong correlation between the Chinook salmon population estimate generated by DFG carcass-counts in lower Battle Creek and the levels of dissolved ammonia and orthophosphate at Jelly's Ferry Road Bridge, a half-mile downstream from the CNFH barrier weir, provides indirect evidence that fall-run salmon carcasses contributed substantial nutrients to Battle Creek (DWR 2001b). However, further studies are needed to determine whether the nutrients added to Battle Creek by decomposing salmon carcasses have any effect on the levels of dissolved oxygen in the creek.

Hydrology

Mean monthly flows for this gage throughout the year are 516 cfs. High flows generally occur during the spring with a maximum monthly average of 766 cfs. Low flows generally occur during mid to late summer and have a minimum monthly average flow of 265 cfs.

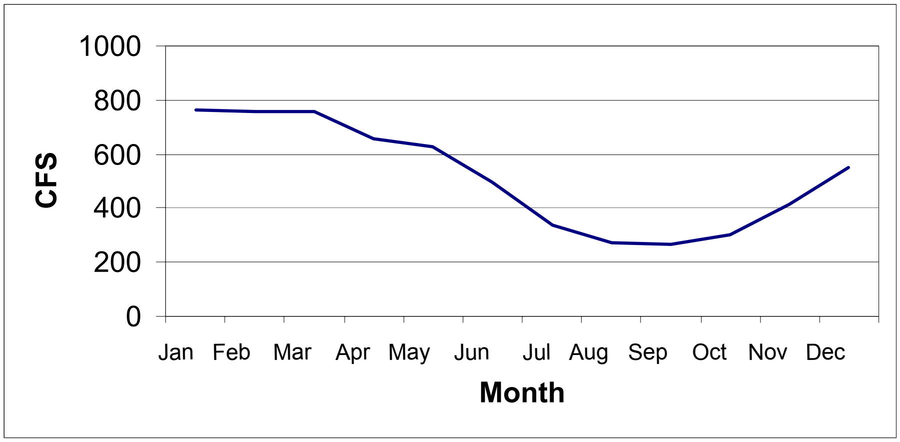

Figure 25. Flows recorded from USGS gage site number 11376550 near Cottonwood Coleman fish hatchery from 1961 to 2000 (USGS 2002).

Habitat Quality

Battle Creek has an unusual combination of desirable habitat features including an abundance of cold water springs, high natural flows, and relatively constant flows during the summer. Prime quality spawning, holding, and rearing habitat for steelhead and winter- and spring-run Chinook is above Wildcat and Coleman dams on the north and south forks of Battle Creek, respectively. The fish habitat and water temperatures in these upper stream reaches are excellent for all life stages of salmon and steelhead (CH2MHill 1998). In contrast, the best quality habitat for fall and late-fall salmon is below Wildcat and Coleman dams (Ward and Kier 1999).

Habitat Data

A fish barrier study and an instream flow study conducted by Thomas Payne and Associates in the 1980s and 1990s formed the basis for the biological goals of the Battle Creek Salmon and Steelhead Restoration Plan (Ward and Kier 1999). The results of the two studies were used to help the Battle Creek Working Group's Biological Team categorize the contribution that distinct stream reaches could have toward the recovery of each of the five salmonid runs (Ward and Kier 1999). In addition, temperature modeling was used to estimate creek water temperatures under a number of different restorable flow regimes (Ward and Kier 1999).

The U.S. Geological Survey (USGS) has maintained a streamflow gaging station on Battle Creek below CNFH since 1961 (USGS 2001). DWR operates two streamflow gaging stations in the Battle Creek watershed near Manton, one on North Fork Battle Creek and one on South Fork Battle Creek. Both gaging stations were installed during 2000 (DWR 2001a).

DWR has 22 thermographs measuring water temperature in Battle Creek. The thermographs at Jelly's Ferry Bridge and below CNFH were installed in 1993 and 1995, respectively. The other 20 thermographs were installed in 1998 and range from Jelly's Ferry Bridge to below the North Battle Creek Dam on the north fork and below South Diversion Dam on the south fork. Field parameters such as dissolved oxygen, pH, electrical conductivity, turbidity, and alkalinity are also collected.

Riparian vegetation along Battle Creek was mapped between 1996 and 1998 by California State University, Chico, Geographic Information Center as part of the Sacramento River Stream Corridor Protection Program and is available from CSUC as an ArcView project file.

Fisheries and Restoration Projects

The most significant factors preventing salmon and steelhead from fully utilizing the upper watershed of Battle Creek are low flows and inadequate passage caused by hydroelectric and hatchery water supply diversions. Restoration of naturally spawning anadromous fish populations in Battle Creek above CNFH will require changes in the operation of PG&E's hydropower plants and the traditional operation of the hatchery. As part of the goal to "restore the Battle Creek watershed for naturally-produced anadromous salmonids, while integrating CNFH operations," USFWS is planning to reduce impacts of its activities on naturally produced salmonids in Battle Creek. This includes studies on methods to improve fish passage at the barrier weir and installation of state-of-the-art fish screens to exclude naturally produced fish from each of three hatchery water intakes (USFWS 1998b). A Senate Bill 1086 plan identified the potential to restore Battle Creek by working cooperatively with PG&E on providing adequate instream flows (Resources Agency 1989). In 1995, Resources Agency representatives and PG&E started to discuss ways to improve fish passage on Battle Creek. These meetings eventually led to the development of the Battle Creek Salmon and Steelhead Restoration Project. This project is focused on increasing and enhancing habitat for Chinook salmon and steelhead trout.

In June 1999, federal and state agencies comprising the CALFED Bay-Delta Restoration Program signed a $51 million agreement with PG&E that will open up 42 miles of inaccessible stream reaches (Ward 1997). The restoration proposal includes:

- Increasing the minimum instream flows from the present 3-5 cfs year-round to 35-88 cfs adjusted seasonally ;
- Decommissioning five diversion dams — Wildcat, Coleman, South, Lower Ripley Creek, and Soap Creek — and transferring their associated water rights to instream uses ;
- Screening and enlarging ladders at three diversion dams — Inskip, Eagle Canyon, and North Battle Creek ; and
- Constructing new infrastructure that eliminates mixing of north and south fork water and significantly reduce redundant screening requirements (CNFH 2000).

In February 1997, the Battle Creek Working Group was established to gather all interested parties affected by the Battle Creek restoration work. BCWG met to develop restoration efforts in a collaborative atmosphere and gather broad community acceptance. BCWG was involved in the development of the Battle Creek Salmon and Steelhead Restoration Plan (Ward and Kier 1999), prepared by Kier Associates.

In April 1997, DWR engineers met with staff from PG&E, DFG, USFWS, USBR, and other agencies to begin investigating fish passage solutions on Battle Creek. These investigations led to the development of three preliminary engineering technical reports on dam removal, power facilities reconfiguration, and fish facilities construction. The dam removal and power facilities reconfiguration reports were completed by USBR in May 2000 and the fish facility construction report was completed by DWR in May 2000. Final design and specifications are being developed by DWR and USBR based on these preliminary designs. Project construction was expected in 2001 and 2002 (Ward 1997).

In October 1998, USFWS Red Bluff Office began monitoring juvenile Chinook salmon and steelhead out-migration from the Battle Creek watershed, which is funded by the Comprehensive Assessment and Monitoring Program (USFWS 2001b). Snorkel counts of adult salmon and steelhead in the watershed was to begin as part of CAMP in summer of 2001. The goal of the monitoring project is to obtain relative abundance and distribution data on Chinook salmon and steelhead in Battle Creek. The information will be used to assess the suitability of the current habitat and provide baseline data to help evaluate restoration activities (Ward 1997). Counts of salmon and steelhead in the upstream ladder of the CNFH barrier weir will be used to monitor the success of Battle Creek restoration efforts (Kier Associates 2001).

Big Chico Creek, Butte County

Potential Impediments to Anadromous Fish Migration

Big Chico Creek has no major reservoirs, but has five small dams and three natural barriers that could impede anadromous fish migration. Four barriers do not have fish passage facilities, but fish are able to get past under adequate flow conditions.

One-mile Dam is managed by the city of Chico's Park Department to create a public swimming pool in Bidwell Park during the summer. In winter, the Park Department installs a shorter flashboard structure to allow a fish ladder to operate. Winter flows deposit large amounts of gravel and debris in the pool area requiring additional maintenance and leaving the creek downstream from the dam depleted of gravel.

At Five-Mile Dam, a 1963 USACE flood control project split Big Chico Creek floodflows into three channels, Big Chico Creek, Sycamore, and Lindo Channel. Unfortunately, design of the flow control structures creates an upstream stilling basin during flood events. This causes gravel to fall out above the diversion, creating a gravel bar that blocks the flow to Lindo Channel unless gravel is mechanically removed. Lindo Channel has often ceased to flow sometimes, trapping adults and downstream migrants several times during a single season (USFWS 1995).

The Iron Canyon fish ladder, built in the late 1950s for fish passage through Upper Bidwell Park, has been severely damaged, delaying or preventing upstream migration of adult spring-run salmon, which then must hold or even oversummer downstream of the ladder where temperatures, human harassment, and poaching are serious problems (USFWS 1995). In addition, altered hydraulics has made fish passage at Bear Hole, a natural constriction in the channel downstream of Iron Canyon, difficult at low flows.

General Description

Big Chico Creek begins around 6,000 feet elevation in the Lassen National Forest of the Cascade Range. It flows westerly about 45 miles to its confluence with the Sacramento River at RM 193. It drains about 72 square miles. Average annual discharge is 102,100 acre-feet (DFG 1965). Summer flows drop to an average of 30 cfs while flow during the winter averages more than 300 cfs (CH2MHill 1993).

Fish Populations

Historically and today, 24 miles of the creek are accessible to fall-, late-fall, and spring-run Chinook salmon, and Central Valley steelhead (NMFS 2000). Large boulders dislodged during the 1906 earthquake blocked access beyond Iron Canyon at RM 14.2. In 1958, construction of a series of small fish ladders restored access. The primary adult holding area is in the reach upstream of Iron Canyon to Higgins Hole. Additionally, a winter Chinook salmon run occurs to Lindo Channel (Maslin).

DFG has conducted spring-run Chinook salmon surveys periodically since 1956. Sporadic surveys of adult holding areas have been conducted since 1986. Starting in 1992, annual snorkel surveys were made of the adult holding area from Iron Canyon to Higgins Hole. Juvenile out-migration is monitored from December through June by using fyke nets placed in the creek near the Five Mile Recreation Area (DFG 1998). Spring-run Chinook salmon populations have ranged from a high of 1,000 in 1958 to none in 1971, 1984, 1985, 1990, and 1992. In 1998, the population estimate was 359 fish (Grandtab, DFG, Red Bluff Office, contact Colleen Harvey, 2000).

Average estimates for steelhead numbers in the 1950s and 1960s were about 150 in Big Chico Creek. Steelhead runs were much likely larger in Sacramento River tributaries before the 1900s (USFWS 1995).

Water Quality

Water quality in Big Chico Creek and Lindo Channel is degraded by cadmium, mercury, and other metals in mine drainage for the upper watershed and by runoff from the urban area. The urban area runoff typically consists of residual petroleum compounds, pesticides, solid pollutants, and other waste products that enter the creek via storm drains (Resource Agency 1989).

During the summer, all of the flow remains in the mainstem of Big Chico Creek. The flows in Lindo Channel and Mud Creek become intermittent (CH2MHill 1998). There is some evidence that temperatures in the summer holding reach for adult spring-run Chinook salmon, from Iron Canyon to Higgins Hole, may approach critical levels in late summer, particularly in low-flow years (USFWS 1995).

Hydrology

Mean monthly flows are 151 cfs recorded from 1930 to 1986. Yearly peak flows occur in mid-February when flows reach 391 cfs. The lowest flows for the period of record occur during the summer and extend into the early fall months receiving flows as low as 25 cfs.

DWR operates two streamflow gaging stations in Big Chico Creek from the golf course to Rose Avenue within the city limits. The golf course and Rose Avenue gaging stations have been collecting continuous records since 1997 and 1956, respectively (DWR 2001).

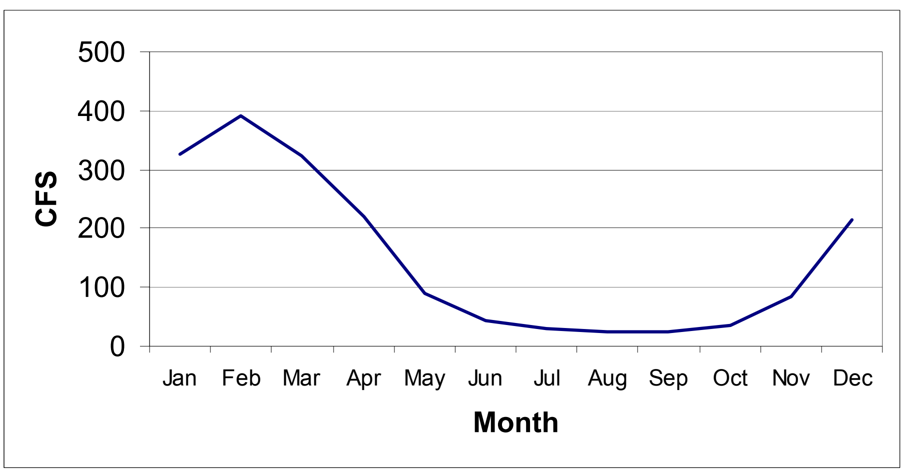

Figure 26. Flows recorded from USGS gage station site number 11384000 near Chico in Butte County (USGS 2002).

Habitat Quality

Higgins Hole, the upstream limit of spring-run Chinook salmon, is the best summer holding habitat in Big Chico Creek. During the summer months, temperature data from the pools at Higgins Hole show daily mean temperatures of 64° F to 68° F.

A 1993 DFG survey concluded that habitat type quantity and quality, pool conditions, and riffle distribution from Five-Mile Dam to the mouth appeared suitable for juvenile salmonid occupation. Most of the land adjacent to the lower creek within the valley floor is developed for agriculture. The valley portions of Big Chico Creek support dense riparian vegetation (Brown 1996).

Habitat Data

DFG conducted stream habitat surveys from Five-Mile Dam to the mouth of Big Chico Creek in 1993 and 1994. A quantitative and qualitative study of physical habitat in Big Chico Creek from Five-Mile Dam to Higgins Hole upstream was conducted in 1994 by DFG and funded by DWR (Brown 1996).

DWR's Northern District office has performed a total watershed water quality analysis on Big Chico Creek from May 1997 through April 1999. The water samples collected were examined for coliform bacteria, minerals, nutrients, metals and suspended solids. A toxicology analysis was also performed to see if anything in the water was adversely affecting living organisms.

DWR has recorded water temperatures in Big Chico Creek since January 1993. There are eight thermographs in the creek starting at Big Chico Creek just above the confluence with Mud Creek to Ponderosa Way. Field parameters such as dissolved oxygen, pH, electrical conductivity, turbidity, and alkalinity are also collected.

Riparian vegetation along Big Chico Creek was mapped between 1996 and1998 by California State University, Chico, Geographic Information Center as part of the Sacramento River Stream Corridor Protection Program and is available from CSUC as an ArcView project file.

Fisheries and Restoration Projects

The Big Chico Creek Watershed Alliance is leading an ongoing project committed to the overall preservation and restoration of the creek (Ward 1997). DWR is performing a preliminary engineering investigation for fish passage improvements at Iron Canyon and Bear Hole on Big Chico Creek and is being funded through the U.S. Fish and Wildlife Service-Anadromous Fish Restoration Program (USFWS-AFRP). The project seeks to provide unimpeded migration for salmon and steelhead over a greater range of flow conditions (Ward 1997).

The city of Chico has had concerns regarding the blockage of gravel flowing downstream, safety, and the costs of maintaining One-Mile Dam. As a result of these concerns, the city has investigated different options for the modification of the structure to enhance the passage of bed load and debris, fish passage, and to improve safety. The city retained the services of Borcalli and Associates to develop the most efficient alternative for modification of the dam. Borcalli and Associates recommended installation of an inflatable, steel dam that would raise and lower hinged steel gates with an inflatable bladder. This would involve little modification to the existing structure. The Park Department was seeking funding assistance for the project, estimated to cost $259,050, and had targeted construction for late summer and fall of 2002.

The city of Chico completed a project in 1987 to restore the riparian habitat that was lost during floods in Lindo Channel, a tributary to Big Chico Creek. DWR funded a project on Big Chico Creek to enhance a 600-foot section of the creek in upper Bidwell Park. This project was completed 31 Dec 1994. In June 1994, the Streaminders of Chico completed a project to repair a 125-foot section of the creek that had been eroded (Ward 1997).

Other projects include a new pumping station built in 1997 to replace the old M&T pumps on Big Chico Creek. The One-Mile (Sycamore) Pool was modified in 1997 by the city of Chico to decrease downstream siltation and turbidity. The modification involved installing a bypass pipe around the pool to allow removal of bedload deposits (USFWS 1998). And, DWR Northern District office conducted preliminary engineering investigations for fish passage improvements at Iron Canyon and Bear Hole during the summer of 2001.

Butte Creek, Butte, Sutter and Colusa Counties

Potential Impediments to Anadromous Fish Migration

The lower portion of Butte Creek consists of two subareas: the Sutter Bypass and Butte Sink. The East-West Diversion Weir, near the upstream end of the Sutter Bypass, divides the flow of Butte Creek into the East Borrow Canal and West Borrow Canal. There are eight migration impediments in the Sutter Bypass, three in the EBC and five in the WBC.

Many channels in the Butte Sink subarea route water through rich farmlands and private duck clubs. The subarea has 13 migration impediments, including eight in Butte Creek, three in Cherokee Canal and two in Sanborn Slough.

General Description

Butte Creek originates at more than 7,000 feet elevation along the western slope between the Cascade Range and the Sierra Nevada. It meanders southeasterly about 89 miles, flowing into the Sacramento River at two points: through the Butte Slough Outfall flap gates at River Mile 139 and through the Sutter Bypass at River Mile 80. The drainage area encompasses about 150 square miles.

Butte Creek is a complex system with water imports from other sources, agricultural diversions, and agricultural return flows. Beneficial uses include hydroelectric generation, irrigation, water transport, gravel extraction, gold mining, recreation, fishing, waterfowl habitat, salmon production, and flood bypass. Fish passage through the Butte Creek system is affected by 34 minor and major structures.

Fish Populations

Butte Creek is one of the most productive spring-run salmon streams in the Sacramento Valley. The adult spring-run fish migrate up the Sutter Bypass and into Butte Creek, navigating past numerous diversions to spawning areas in the upper Butte Creek system (Jones and Stokes 1998). Spring-run Chinook salmon ascend to Centerville Head Dam near DeSabla. Steelhead are restricted to the lower reaches of the canyon and tributaries such as Dry Creek (McEwan and Jackson 1996). Historically, a portion of the spring-run and Central Valley steelhead may have spawned in reaches farther upstream. Today, about 53 miles of the creek is accessible to fall-, late-fall, and spring-run Chinook salmon and Central Valley steelhead (NMFS 2000).

Since 1993, DFG has performed adult spring-run snorkel studies at least twice a year between Centerville Head Dam and the Parrott-Phelan Diversion Dam. Holding adult spring-run salmon are counted in late August. In late September, the survey is repeated and live salmon, carcasses, and redds are counted. Spring-run population estimates have ranged from a high of 20,259 in 1998 to a low of 10 in 1979. The 1999 population estimate was 3,679 fish (Grandtab, DFG, Red Bluff Office, contact Colleen Harvey, 2000).

In 1995, a study began to monitor downstream migrating juvenile spring-run Chinook salmon in Butte Creek. Critical information obtained includes time of emergence, instream rearing and emigration patterns, size at emigration, duration of emigration, and a measure of relative abundance. The purpose of the study is also to code wire tag as many spring-run juvenile salmon as possible so that growth and timing can be monitored as juveniles move downstream (DFG 1998).

Water Quality

Water quality conditions affect survival and growth of juvenile Chinook salmon rearing and migration through Butte Sink. Water temperature and dissolved oxygen are the primary water quality concerns. Given the generally shallow water depth, less than 4 feet during controlled conditions, and the flow-through nature of the system, dissolved oxygen is not expected to be a concern. Water temperatures during the period when flows are managed and juvenile Chinook salmon are present, October through 15 Jan, are likely near optimal ranges. Water temperature could be a concern during both the month of October and in late spring (Jones and Stokes 1999).

Potential agriculture contaminants enter the stream with irrigation return water that is unmonitored. Increased agricultural return to the total flow during the diversion season can increase the effects of contaminants on fish (USFWS 2000).

Butte Creek is perennial, with peaks in streamflow during storms and spring runoff. Instream flows downstream of Gorrill Dam during irrigation season, between mid-July and September, are typically less, with flows in the range of 5 to 25 cfs in most years (CH2MHill 1996).

The hydrology of lower Butte Creek varies substantially (Jones and Stokes 1998). During winter and spring of wet years, the Butte Sink and Sutter Bypass are flooded most of the time. During dry years, water flows are low. Water imported from the Sacramento and Feather Rivers substantially augments natural flows during dry years (Jones and Stokes 1998).

Hydrology

Flows from the gage station near Chico show that the mean monthly flow for period of record is 417 cfs. Peak flow occurs during mid-February at 826 cfs and the lowest flows throughout the year occur in September at 119 cfs.

DWR operates three streamflow-gaging stations on Butte Creek. The stations are between Durham and the Sacramento Slough near Carnac and have been taking continuous recorded records since 1958. Streamflow data can be accessed through California Data Exchange Center (CDEC) (DWR 2001).

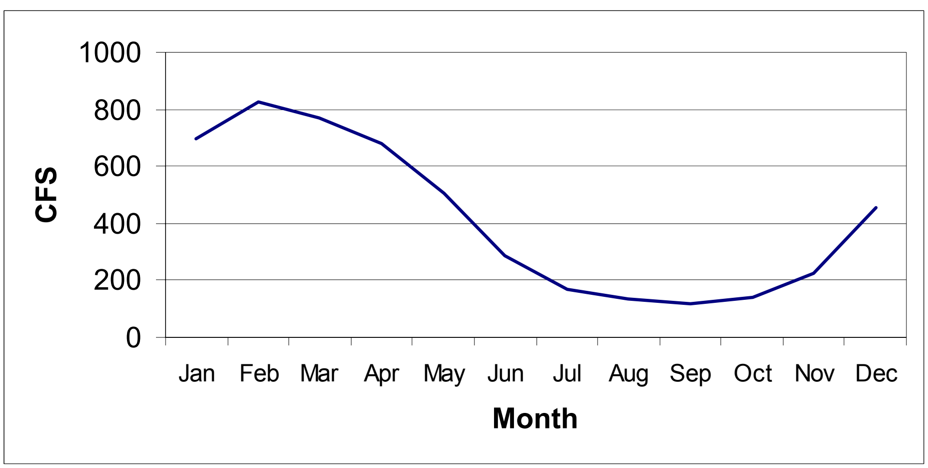

Figure 27. Flows are recorded from USGS gage station site number 11390000 near Chico in Butte County from 1930 to 2000 (USGS 2002).

Habitat Quality

Habitat in the Butte Creek system is complex and varies by time and place. The reach between the Centerville Head Dam and the Centerville Powerhouse is relatively remote and has deeply incised canyons and deep spring-fed pools that provide the best summer adult holding potential on the entire creek (DFG 1998).

The reach from the Centerville Powerhouse down to Parrot-Phelan Dam has undergone and continues to undergo significant residential development. The reach contains the remainder of the summer adult holding habitat and most of the potential spawning habitat for spring-run fish (DFG 1998).

Agriculture has heavily impacted the valley reach from Parrot-Phelan Diversion to the Butte Sink. Within this reach, the Western Canal Water District has conveyed Feather River water into and across Butte Creek. Levee installation, maintenance, and repair have altered natural stream processes such as channel meander and have affected riparian vegetation. Below Highway 162, return agriculture drainage flows into Butte Creek, which may detrimentally affect migration and water quality (DFG 1998).

The Butte Sink area is between the Gridley-Colusa Highway and Butte Slough Outfall gates on the Sacramento River south of Colusa. Within the Butte Sink, duck clubs and agriculture divert and reroute flows. Additionally, major drains and flood overflows converge into the Butte Sink and alter water quality and attraction flows that detrimentally affect migration and rearing of salmon (DFG 1998).

In the Sutter Bypass, flows are regulated through the Butte Slough Outfall gates about 5 miles south of Colusa, to accommodate both flood control and agriculture. There are various flow control structures that directly impact both migrating adults and migrating and rearing juvenile spring-run salmon (DFG 1998).

Habitat Data

DWR has measured water temperatures in Butte Creek since September 1994. There are thermographs at 12 locations from the Sutter Bypass to above DeSablo Powerhouse. Water temperature data can be accessed through CDEC. Field parameters such as dissolved oxygen, pH, electrical conductivity, turbidity, and alkalinity are also collected.

DWR's Northern District office started a comprehensive watershed water quality analysis of Butte Creek in October 2000. Water samples are collected at five locations from Sutter Bypass to above DeSablo Powerhouse. The water samples are analyzed for coliform bacteria, minerals, nutrients, metals and suspended solids. A toxicology analysis is also performed to see if anything in the water is adversely affecting living organisms.

Riparian vegetation along Butte Creek was mapped between 1996 and 1998 by California State University, Chico, Geographic Information Center as part of the Sacramento River Stream Corridor Protection Program and is available from CSUC as an ArcView project file.

Fisheries and Restoration Projects

There are fish passage problems at diversion dams and pumping sites throughout the Butte Creek system, and several agencies and water districts have been working to restore the creek's salmon populations while preserving the integrity of the water users' operations. The Western Canal Water District led a project to restore unimpeded fish passage through the middle reaches of the main stem of Butte Creek. As a result, five diversion dams were removed: Western Canal Main Dam, Western Canal East Channel Dam, Point Four Dam, McGowan Dam, and McPherrin Dam.

In the early 1990s, DFG led a multiagency effort, in cooperation with landowners that led to several structural improvements in the Butte Creek system. In 1994, DFG designed and inspected construction of a fish screen at Parrott-Phelan Diversion Dam. In 1995, DFG completed preliminary designs and DWR prepared final designs and jointly (with DFG) inspected construction of a pool and chute fish ladder at the PPDD. DWR then completed preliminary engineering designs for new fish ladders and fish screens at Durham Mutual, Adams, and Gorrill Diversion Dams. Fish ladders and screens were constructed at those three sites in 1997. DWR also completed a preliminary engineering investigation of fish passage and flow control improvements at the Sanborn Slough/Butte Creek Bifurcation Structure near Gridley. The flow control and fish ladder structure was constructed in 1999.

DWR plans to conduct preliminary engineering investigations for additional sites in the creek system, including pumping plants along the east side of the Sutter Bypass. Design and construction of fish screens at the three pumping plants are part of the Lower Butte Creek Project, a multifaceted plan to improve fish passage through the Lower Butte Creek system. The LBCP is being coordinated by Ducks Unlimited, with various private consulting firms working on flow improvements and designs at several structures.

DWR's Northern District office began a two-year watershed analysis on Butte Creek in 2002 to evaluate water quality, determine suitability of the aquatic habitat to support aquatic species, and determine the suitability of the water to support beneficial uses. It will also establish baseline conditions to gauge effectiveness of restoration.

Clear Creek, Shasta County

Potential Impediments to Anadromous Fish Migration

Whiskeytown Dam and reservoir, with a capacity of 241,000 acre-feet, stores natural creek flows and water diverted from the Trinity River at Lewiston Dam through the Clear Creek Tunnel (DWR 1986). Whiskeytown Dam is impassible, making it the upstream limit of anadromous fish migration. Saeltzer Dam was removed in November 2000. It was downstream from Whiskeytown Dam and 6 miles upstream of the confluence with the Sacramento River. Along with reduced flow, it limited anadromous species in the creek. A sheet piling dam, constructed by the USBR to protect the Anderson-Cottonwood Irrigation District Canal's inverted siphon, still remains but is not considered a barrier to fish passage. Even though it appears as a potential barrier, the stepped spillway in the center, combined with a deep plunge pool, does not appear to significantly hinder fish passage (DWR 1986).

General Description

Clear Creek, the first major natural tributary to the Sacramento River below Shasta Dam, originates in the Trinity Mountains west of Shasta Lake about 3,000 feet elevation. It flows southeasterly about 50 miles to its confluence with the Sacramento River at River Mile 289, south of Redding. It drains roughly 238 square miles. The average annual yield in Clear Creek before 1963 was 302,000 acre-feet. Since the construction of Whiskeytown Dam in 1963, the average annual yield in Clear Creek averaged 112,000 acre-feet, a 63 percent reduction in flow (North State Resources 1999).

Fish Populations

Historically, 25 miles of the creek was accessible to fall-, and late-fall run Chinook salmon, and Central Valley steelhead (NMFS 2000), spring-run Chinook salmon probably migrated to the uppermost reaches. Azevedo and Parkhurst (1958) mentioned seeing spring-run salmon in 1956 for the first time since 1949, but gave no estimate of the population size (DFG 1998). Steelhead have been reported in Clear Creek below Saeltzer Dam. However, the creek has not been surveyed for spawning adults, therefore the status is unknown (McEwan and Jackson 1996). Today, only 6 miles of the creek is accessible to fall- and late-fall run Chinook salmon (NMFS 2000). With Saeltzer Dam removed, about 10 more miles of habitat are available.

The Department of Fish and Game has conducted fall-run Chinook salmon carcass tag and recapture studies since 1953. The surveys have been conducted within the major spawning areas from Saeltzer Dam to about 4 miles downstream. Fall-run spawning populations have ranged from a high of 10,000 fish in 1963 (the year Whiskeytown Dam was completed) to a low of 60 fish in 1978. The 1999 population estimate was 8,003 fish (Grandtab, DFG, Red Bluff Office, Contact Colleen Harvey 2000).

Water Quality

The water temperature during late spring and summer is often life threatening for salmon and steelhead rearing in the lower portion of Clear Creek, between the former Saeltzer Dam site and the Sacramento River. When releases from Whiskeytown Dam were 50 cfs, water temperatures commonly reached a maximum of 75 degrees F, a lethal level for salmonids (North State Resources 1999).

Hydrology

The completion of Whiskeytown Dam and the operation of the U.S. Bureau of Reclamation's (USBR) facilities have significantly altered the hydrology of Clear Creek. Instream flow has been dramatically reduced from historical flow regimes, especially from winter through spring. The recommended releases from Whiskeytown Dam to Clear Creek are 200 cfs from October to April and 150 cfs for the rest of the year with variable springtime releases depending on water-year type (North State Resources 1999).

Monthly mean flow on Clear Creek near French Gulch is 211 cfs. Flows during the summer become exceptionally low, down to 15 cfs. The highest flows during the year for this gage station are during the winter when flows reach a mean 543 cfs for period of record.

The U.S. Geological Survey operates a streamflow gaging station on Clear Creek near Igo. The station has been in place since September 1940 (USGS 2001).

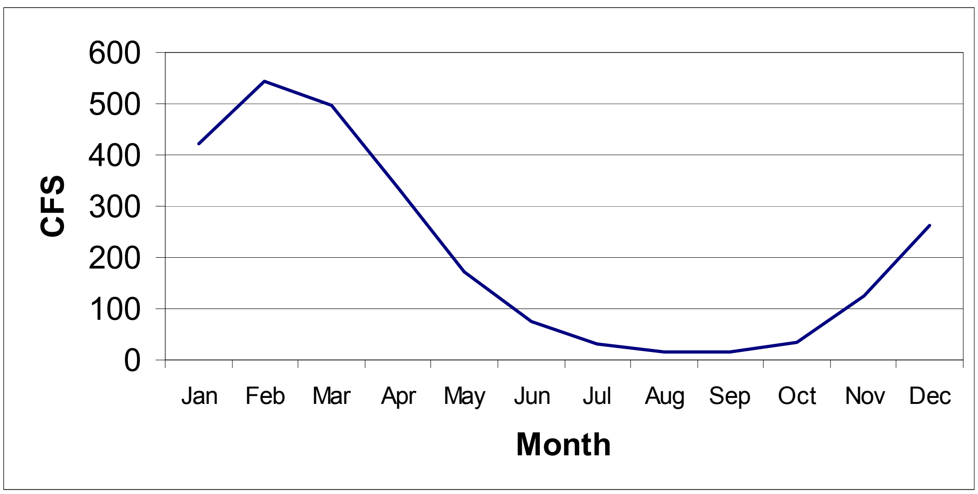

Figure 28. Flows recorded from USGS gage station site number 11154700 near French Gulch, Shasta County, in years 1950 to 1993 (USGS 2002).

Habitat Quality

Riparian habitat along Clear Creek has been significantly affected by gold dredging, gravel extraction, water diversion, and flow regulation. These impacts include removal of some riparian forests, alteration of floodplain morphology by mining, and encroachment of riparian vegetation into the low-flow stream channel due to flow regulation. On floodplain surfaces, the existing riparian vegetation occurs between large tailing piles and other landscapes disturbed by historical gold and gravel mining (North State Resources 1999).

Clear Creek has also experienced fishery habitat degradation, including sedimentation from decomposed granite sand, removal of spawning gravel by gravel mining, and gravel trapped behind Whiskeytown Dam. A gravel recruitment/replenishment program has been implemented by the Western Shasta Resource Conservation District to replace the lost recruitment and removed spawning gravel. A total of 8,000 tons of gravel per year has been introduced below Saeltzer Dam for the past four years, according to Jeff Souza of the Western Shasta Resource Conservation District in Redding. The suitability of gravel in Clear

Creek for salmon spawning was investigated in 1965 and 1982. The quality of Clear Creek spawning gravel has declined markedly since 1965. In 1982, 13 riffles below Saeltzer Dam and five riffles above were surveyed and size composition of streambed samples was analyzed. None of the samples taken in 1982 met DFG criteria for suitable spawning gravel, whereas 75 percent of those taken in 1965 met the criteria (DWR 1986).

Coordinated efforts to restore a mined area on public lands within the lower Clear Creek watershed (below Whiskeytown Dam) have been implemented through the Hubbard Mine Reclamation Project. The purpose of this project is to increase healthy spawning areas for salmonids by reducing sedimentation (Ward 1997).

Habitat Data

DWR has recorded stream temperatures near the Redding Wastewater Treatment Plant at RM 0.3 since 1993. DWR installed additional thermographs at the Saeltzer Dam site, RM 6, and the ACID siphon, RM 1.2, in October 1995. DFG installed a thermograph near the Placer Road Crossing, RM 10.4, in October 1995. From September 1991 through May 1995, DFG maintained seasonal thermographs near both the Placer Road Crossing and at the National Environmental Education Camp (Brown 1995).

DWR's Northern District office performed a total watershed water quality analysis on Clear Creek from October 1997 through August 1999. The water samples collected were examined for coliform bacteria, minerals, nutrients, metals, and suspended solids. A toxicology analysis was also performed to see if anything in the water was adversely affecting living organisms.

The U.S. Fish and Wildlife Service conducted stream width surveys during varying flow releases in 1995. Portions of Clear Creek that include the primary spawning areas for salmon were surveyed on foot in September, October, and November 1995. Flows at Igo were 72, 99, and 144 cfs respectively. Stream width measurements were made, photographs were taken, and the number and condition of salmon were visually estimated (Brown 1995).

Riparian vegetation along Clear Creek was mapped between 1996 and 1998 by California State University, Chico, Geographic Information Center as part of the Sacramento River Stream Corridor Protection Program and is available from CSUC as an ArcView project file.

Fisheries and Restoration Projects

The Saeltzer Dam Fish Passage and Flow Protection Project, led by USBR, increased and improved anadromous fish habitat in Clear Creek. Saeltzer Dam, a 15-foot-high by 200-foot-long concrete diversion dam at RM 6.2 and built in 1903, was demolished in November 2000. Elimination of the dam opened up 10 miles of cold-water habitat below Whiskeytown Dam. Increased flow releases from Whiskeytown Dam will improve water quality and temperature conditions in the creek (North State Resources 1999).

There have been several recent projects in the Clear Creek watershed. The Lower Clear Creek Floodway Rehabilitation Project below Whiskeytown Dam is expected to restore 2.9 miles of floodplain and riverine aquatic habitats. This project will reduce stranding of anadromous fish in gravel mining pits, as well as increase riparian habitat. WSRCD, USBR, and U.S. Bureau of Land Management (BLM) are the lead agencies on this project, which had been scheduled for completion by January 2002.

The Lower Clear Creek Vegetation Management project, led by WSRCD, was started 1 Jan 1996, and is expected to continue. It is a coordinated effort to protect the Lower Clear Creek watershed and inhabitants from wildfire and promote a healthy ecosystem. Another ongoing habitat restoration project is the Spawning Gravel Injection project, also led by WSRCD. It started in January 1996. WSRCD led the Hubbard Mine Reclamation project, completed in April 1998. It restored upland areas and reduced erosion (Ward 1997).

Mill Creek, Tehama County

Potential Impediments to Anadromous Fish Migration

There are no major reservoirs on Mill Creek, but the two diversions, Ward Dam and Upper Diversion Dam, have historically diverted most of the natural streamflow, particularly during dry years. Clough Dam, a private diversion serving the properties of two local landowners, was partially washed out in the 1997 flood. There is a project proposal to remove the remains of the dam and install an inverted siphon under Mill Creek to carry water diverted at the Upper Diversion Dam to water users.

General Description

Mill Creek originates on the southern slope of Mount Lassen at an elevation of about 7,000 feet. It flows westerly about 60 miles to its confluence with the Sacramento River at RM 230, a mile north of Tehama. It drains about 134 square miles. The monthly mean runoff ranges from 105 to 465 cfs with a median runoff of 333 cfs (USFWS 1998).

Fish Populations

Mill Creek supports runs of spring-, winter-, and fall-run Chinook salmon and Central Valley steelhead. Historically and today, 44 miles of the creek are accessible to these species (NMFS 2000). Spring-run salmon have been observed spawning at an elevation of 5,300 feet in Mill Creek, the highest known spawning activity in California (DFG 1993). The winter-run salmon are found in the lower reaches of Mill Creek (Menchen 1964).

DFG has conducted fall-run Chinook salmon surveys since 1952. Carcass tag surveys and recapture studies have been conducted since the 1970s. Surveys are conducted between the mouth, about a mile upstream of the Upper Diversion Dam, to the confluence with the Sacramento River. Fall-run salmon populations have ranged from a high of about 16,000 in 1952 to a low of 150 in 1965. Since 1992, only five surveys have been conducted. The five-year average was 1,036 fish. In 1998, the population estimate was 546 fish (DFG 2000).

From 1947 to 1953, estimates of spring-run Chinook salmon were completed by the U.S. Fish and Wildlife Service based on spawning area surveys or aerial redd counts (Fry 1960). DFG has also conducted spring run surveys since 1954. The surveys are conducted in the major spawning areas from the Lassen National Forest boundary to about 2 miles below the Little Mill Creek confluence. Since 1997, a redd count survey has been conducted to estimate the spring-run population, where a 1:1 male to female ratio and a 1:1 female to redd ratio is assumed. Yearling out-migration is monitored with a rotary screw trap at the Upper Diversion Dam from October through December (DFG 1998). Spring run spawning populations have ranged from a high of 3,500 in 1975 to a low of 61 in 1993. The 1999 population was estimated at 560 fish (Grandtab, DFG, Red Bluff Office, contact Colleen Harvey 2000).

Steelhead counts before 1967 enumerated populations in excess of 1,000 in Mill Creek (Mills and Fisher 1993 in USFWS 1995). In 1993, a fish counter was installed in Mill Creek at Clough Dam. The counter was in place from mid-October 1993 to mid-January 1994 but did not operate continuously due to a malfunction and high flows. Fourteen steelhead were visually counted, which yielded a total estimate of 28 adult steelhead passing Clough Dam. This estimate should be considered a minimum estimate because of discontinuous operation of the counter (DWR and USBR 1999).

Water Quality

Mill Creek differs from other eastside streams due to its high silt load and turbidity during the spring snowmelt. Much of this silt originates from naturally occurring volcanic ash in Lassen Volcanic National Park (DFG 1993). Siltation in upstream spawning and rearing areas between Highway 36 and Big Bend has become severe enough to adversely affect salmonid production.

During the irrigation season, the streamflow is reduced, causing the water temperature to rise. In dry years, when natural streamflows are low and diversions are operating, increased water temperatures can create a thermal barrier, preventing or delaying salmonid migration.

Hydrology

Mill Creek receives streamflow from both seasonal rainfall and snowmelt. From 1929 to 1994, Mill Creek had an average annual runoff of 215,000 acre-feet, equivalent to a mean annual flow of 297 cfs, and a median flow of 175 cfs. Stream discharge peaks during the winter through spring and declines during the summer. It is caused by natural reductions in runoff and water diversions. Typically, water is diverted from April through October (CH2MHill 1998).

USGS operates a streamflow gaging station on Mill Creek near Los Molinos. The station has been in place since 1909, but only fragmentary records exist from 1909 to 1913. Continuous streamflow water records exist from October 1928 (USGS 2001).

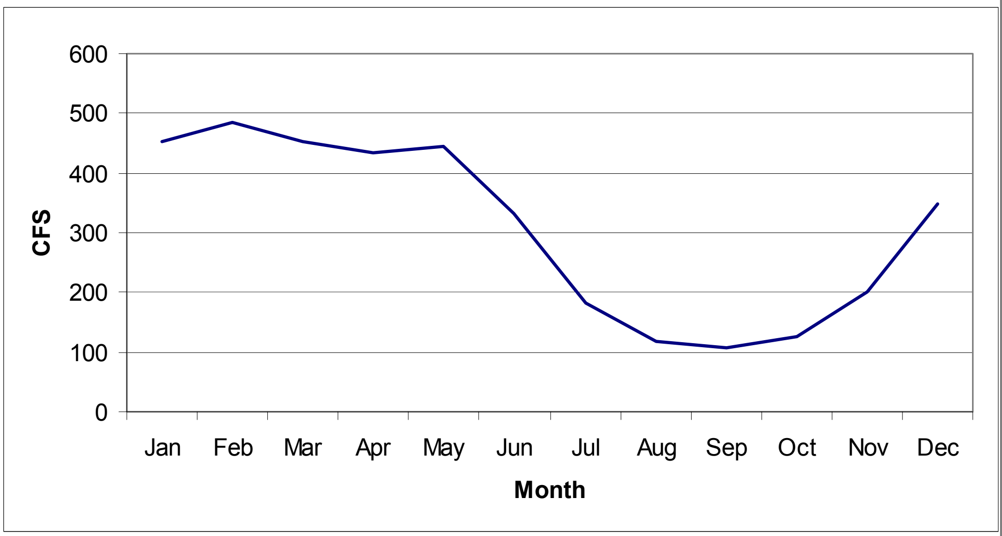

Figure 29. Flows measured from USGS gage station site number 11381500, in Los Molinos, Tehama County, from 1928 to 2000 (USGS 2002).

Habitat Quality

Potential spawning areas on the Valley floor of Mill Creek consist primarily of large cobbles and boulders with very little, good-quality spawning gravel. The majority of the spawning gravel is trapped behind the diversion dams until they become full and the excess is washed downstream or is flushed from the stream by storms. The upper reaches of the creek contain deep, cold pools, which provide excellent spring-run holding habitat.

Residential development near Los Molinos is encroaching on Mill Creek's riparian corridor and has the potential, through cumulative impact, to significantly degrade the habitat of the lower creek (USFWS 1995b).

Habitat Data

DWR has measured water temperature in Mill Creek since January 1993. There are thermographs at eight locations starting at the mouth of the creek to just below Highway 36. Field parameters such as dissolved oxygen, pH, electrical conductivity, turbidity, and alkalinity are also collected.

DWR's Northern District office performed a total watershed water quality analysis on Mill Creek from May 1997 through April 2000. The water samples collected were examined for coliform bacteria, minerals, nutrients, metals and suspended solids. A toxicology analysis was also performed to see if anything in the water was adversely affecting living organisms.

Riparian vegetation along Mill Creek was mapped between 1996 and 1998 by California State University, Chico, Geographic Information Center as part of the Sacramento River Stream Corridor Protection Program and is available from CSUC as an ArcView project file.

The U.S. Forest Service in Lassen National Forest conducted a survey of holding pools used by spring-run Chinook salmon in 1985 on Mill and Deer Creeks. There were three stream segments surveyed, totaling around 5.5 miles of the creek, which covered a range of elevation and habitat conditions. On Mill Creek, only the number of fish observed were recorded, not the number of pools. They observed a total of 27 adult salmon. The counts increased from upper to lower segments. However, poor visibility in the uppermost segment may have substantially reduced the number of fish recorded (Airola and Marcotte 1985).

Fisheries and Restoration Projects

Ward Dam was rebuilt in 1997 and DFG personnel constructed a new modified pool and chute ladder. The fish ladder provides passage at lower flow conditions whereas the dam is considered passable at higher flow conditions.

A new fish screen was constructed by DFG personnel in the Los Molinos Mutual Water Co. Diversion ditch to replace an onstream fish screen at the Upper Diversion Dam. The new screen, completed in early 2000, is better protected from high flows in its new location downstream of the old screen.

The Clough Dam Siphon and Fish Screen Project, led by DWR, began in 1998. This project is designed to improve upstream fish passage for adult salmon and steelhead by removing the remains of Clough Dam and constructing an inverted siphon under Mill Creek (Ward 1997).

There are four ongoing watershed projects in the Mill Creek drainage. The Lower Mill Creek Riparian Restoration Project is funded by the Mill Creek Conservancy and The Nature Conservancy. The objective is to maintain and restore riparian habitat along the lower reaches of Mill Creek to help sustain cool water temperatures for fall, late-fall, and spring-run Chinook salmon and steelhead trout.

The Deer and Mill Creek Watershed Project started in 1994 and is funded by the State Water Resources Control Board. The purpose is to develop coordinated resource plans to address fisheries, habitat, and watershed impacts to fisheries, and increase water flows to benefit spring-run Chinook salmon (Ward 1997).

USFS is leading the Deer, Mill, and Antelope Creek Stabilization Project, funded by CALFED. The project objective is to reduce generation of fine sediments from upland and riparian road-related sources in the respective watersheds (Ward 1997).

The Mill Creek Water Exchange Program was started in the mid-1990s. Los Molinos Mutual Water Co. has worked with the resource agencies to develop and implement the water exchange program. The program trades groundwater for stream diversion water, increasing stream flows and improving fish passage in the lower reaches of the creek.

Sacramento River, Upstream of Feather River

Potential Impediments to Anadromous Fish Migration

On the mainstem, there are two diversion dams, Red Bluff Diversion Dam and Anderson Cottonwood Irrigation District Dam, which impede anadromous fish migration during the spring and summer. ACID has completed two state-of-the-art fish ladders that will significantly improve passage for salmonids at their dam. Keswick Dam, just below Shasta Dam, is a total barrier to migration.

Shasta Dam, completed in 1944 by USBR, blocks more than 600 miles of historical anadromous fish habitat in upstream tributaries to Shasta Lake. Below Keswick Dam, the river still supports all four runs of Chinook salmon, as well as Central Valley steelhead.

General Description

The Sacramento River Basin covers nearly 27,000 square miles, making it the largest river system in California. The river's tributaries stretch into the Sierra Nevada, the Coast Range, the Cascade Range, and the Modoc Plateau, with headwaters emanating from above 10,000 feet elevation. California's premier river produces about a third of the state's natural runoff and provides benefits that enrich the entire state. The Sacramento River system contributes greatly to the state's and entire Pacific Northwest sport and commercial salmon fishing industries, producing more than 70 percent of the salmon caught off the California coast (Resources Agency 1989). The following information pertains to the Sacramento River above the Feather River confluence.

Fish Population

Historically, about 382 miles of the Sacramento River was accessible to all four runs of Chinook salmon, Central Valley steelhead, Sacramento splittail, green and white sturgeon, striped bass, and American shad (NMFS 2000). Today, only 302 miles are accessible (NMFS 2000). The river serves primarily as a corridor for anadromous fish accessing tributary streams. In addition, about 7,996 winter-run Chinook spawned in the river between Red Bluff and Keswick Dam (DFG 2002), and fall-run also spawn and rear in the river.

Fish counts at Red Bluff Diversion Dam (RBDD) have been conducted by a cooperative arrangement with U.S. Fish and Wildlife Service (USFWS) and the state Department of Fish and Game (DFG). USFWS operates a video-monitoring camera in the fish ladder, while DFG operates a fish trap and provides a population estimate. Until 1994, the gates at RBDD were down year-round and fish could be counted throughout the migration period. Today, the gates are down from 15 May to 15 Sep and the methodology for counting all runs of Chinook salmon has to be extrapolated from historical data.

Since 1967, DFG has estimated fall-run Chinook salmon populations from RBDD to Keswick Dam. The fall-run estimates have ranged from a high of 114,600 in 1969 to a low of 4,824 in 1998. Annual run-size declined from an average of 179,000 adults during 1953 to 1966 to an average of 77,000 adults during 1967-1991 (USFWS 1995). The 1999 population estimate was 48,418 (Grandtab, DFG, Red Bluff Office, contact Colleen Harvey 2000).

DFG has conducted carcass surveys for late-fall run Chinook salmon since 1998. The population estimates passing RBDD were 9,717 in 1998 and 8,683 in 1999 (Grandtab, DFG, Red Bluff Office, contact Colleen Harvey 2000).

Before construction of Shasta and Kewick Dams in 1944 and 1950 respectively, winter-run Chinook salmon were reported to spawn in the upper reaches of the Little Sacramento, McCloud, and lower Pit rivers (Moyle et al 1989 in USFWS 1995) and Slater (1963 in USFWS 1995) stated that this run was small and limited to the McCloud River. California archives indicate the run may have numbered over 200,000. The run was estimated at 80,000 adults by the mid 1960s (USBR 1986 in USFWS 1995). Since 1970, DFG has conducted winter-run Chinook salmon population estimates passing RBDD. The winter run population estimates have ranged from a high of 53,089 in 1971 to a low of 142 in 1994. The five-year average from 1995 to 1999 was 1,741 fish. The 1999 population estimate was 3,184 (Grandtab, DFG, Red Bluff Office, contact Colleen Harvey 2000). In 2001, 7,500 winter-run spawned in the river between Red Bluff and Keswick Dam (DFG 2002).

Spring-run Chinook salmon held and spawned in the middle reaches of the San Joaquin, Feather, upper Sacramento, McCloud, and Pit rivers upstream of present major dams. Smaller runs occurred in tributaries large and cold enough to support adults during the summer holding period. By 1966, only remnant populations of this run were present below these dams (USFWS 1995).

Annual estimates of total Sacramento River steelhead runs upstream of both the American and Feather Rivers at the Fremont Weir ranged from 14,340 to 28,400 from 1953-1959, and averaged 20,500 (Skinner 1962 in USFWS 1995).

Water Quality

Warmer water in the Sacramento River has been a major factor in the decline of winter-run Chinook salmon. High water temperatures result mostly from inadequate carryover storage in Shasta Lake and other reservoirs (McEwan and Jackson 1996). To compensate, a temperature control device was installed at Shasta Dam to help alleviate the problem of warm water releases through the power generating turbines and a temperature control curtain was placed in Whiskeytown Reservoir where water is diverted to the Sacramento River (DFG 1993).

Hydrology

The annual mean flow at Keswick from 1964 to 1999 was 10,330 cfs, ranging from a high of 18,230 cfs in 1974 to a low of 5,390 cfs in 1992. The annual mean flow at Verona, from 1946 to 1999, was 20,050 cfs, ranging from a high of 39,150 cfs in 1983 to a low of 7,178 cfs in 1977.

DWR operates four streamflow gage stations in the Sacramento River from Vina to Butte City. The Vina gaging station has been collecting records since 1946. Streamflow data can also be accessed through CDEC (DWR 2001).

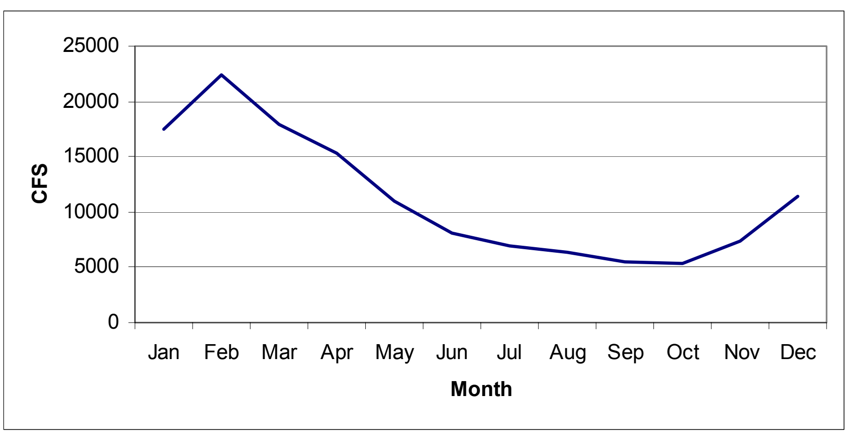

Figure 30. Flows were measured from USGS gage station site number 11378000 in Tehama County from 1902 to 1968 (USGS 2002).

Habitat Quality

Shasta and Keswick Dams have significantly altered gravel recruitment and distribution into the Sacramento River contributed by upstream tributaries. The lack of gravel recruitment to salmon and steelhead spawning beds in the river is most acute in the uppermost 15 miles (Resources Agency 1989). Also, many of the tributaries below Shasta Dam have been gravel-mined for decades, reducing bedload replenishment to the river.

About 150 years ago, the Sacramento River was bordered by up to 500,000 acres of riparian forest, with bands of vegetation spreading 4 to 5 miles. As agriculture and urban areas developed along the river, the riparian vegetation was gradually reduced. Today, less than 5 percent of the original acreage remains (Resources Agency 1989). Many factors have resulted in this considerable reduction of riparian habitat including flood control channelization, timber and fuel harvesting, dam and levee construction, and bank protection.

Habitat Data

DWR has measured water temperature in the Sacramento River since 1987. There are six thermographs from Keswick Dam to Knights Landing. The temperature data can be accessed through the California Data Exchange Center.

Riparian vegetation along the Sacramento River was mapped between 1996 and 1998 by California State University, Chico, Geographic Information Center, as part of the Sacramento River Stream Corridor Protection Program and is available from CSUC as an ArcView project file.

Fisheries and Restoration Projects

Several restoration projects have begun along the Sacramento River because of the dramatic decline over the past several decades in salmon and steelhead populations and riparian habitat. The Upper Sacramento River Fisheries and Riparian Management Plan, led by the Resources Agency, were completed in 1989. The document spelled out plans for riparian habitat protection and fishery restoration, and recommended that legislation be enacted to allow for implementation of the plans.

The Central Valley Project Improvement Act of 1992 was enacted for the protection, restoration and enhancement of fish and wildlife and their habitats. The act also dedicated 800,000 acre-feet of Central Valley Project water for fish and wildlife purposes, provided for anadromous fish restoration, and created a restoration fund financed by water and power users. Completed fish protection and enhancement projects include construction of fish screens and ladders along the Sacramento River and its tributaries, water quality improvement projects, and habitat preservation and restoration programs.

Increases in anadromous fish populations, which can be at least partially attributed to these projects, have already been observed. Several structural fish passage projects have been completed, or are nearing completion, on the Sacramento River. These include the Glenn-Colusa Irrigation District (GCID) Hamilton City Pumping Plant fish screens, the Red Bluff Diversion Dam Research Pumping Plant, the Red Bluff Diversion Dam Fish Passage Improvement Project, the Anderson Cottonwood Irrigation District Dam Fish Passage Project and numerous other fish screen facilities at irrigation pumps.

The objectives of the Red Bluff Diversion Dam Fish Passage Improvement Project, jointly coordinated by the Tehama-Colusa Canal Authority (TCC) and USBR, are to substantially improve:

- The long-term ability to reliably pass anadromous fish and other species of concern, both upstream and downstream, past the Red Bluff Diversion Dam

- The long-term ability to reliably and cost-effectively move sufficient water into the TCC and meet the needs of the water districts (CH2MHill 2001).

Preliminary engineering designs for the three alternative operational scenarios determined to be the most viable approaches to resolving the fish passage and water supply issues at RBDD were completed in February 2001 (CH2MHill 2001). Alternative projects include combinations of improved fish ladders, improvements to pumping capabilities, and seasonal or complete removal of the dam gates, or creation of a bypass channel facility, one of which could begin construction by 2003. (Ward 1997).

The Anderson Cottonwood Irrigation District Dam Fish Passage Project, funded by CALFED, will allow an additional 3.5 miles of the Sacramento River between ACID Dam and Keswick Dam more easily accessible to all runs of Chinook salmon, steelhead, and sturgeon species for spawning and rearing during irrigation season when the dam is installed. The project modified a seasonal flashboard dam by constructing two fish ladders and a fish screen. The right bank pool and chute fish ladder and fish screen were completed in 2000. The left bank vertical slot fish ladder, complete with public fish viewing facilities, was completed in 2001 (Ward 1997).

Yuba River, Yuba County

Potential Impediments to Anadromous Fish Migration

The Harry L. Englebright Lake Dam, constructed in 1941 to hold back hydraulic mining debris, is the upstream limit for anadromous species. Most of the water released from Englebright is passed through the Narrows 1 and 2 powerhouses for hydroelectric power generation. The 0.2-mile of river between the dam and powerhouses has no flowing water except when the reservoir is spilling. Downstream of the powerhouses below the confluence of Deer Creek, the river enters the Narrows, a 1.3-mile-long bedrock gorge where the river forms a single large, deep, boulder-strewn pool. Downstream of the Narrows, the river canyon opens into a wide alluvial floodplain where large volumes of hydraulic mining debris remain from past gold mining.

Downstream from Englebright, Daguerre Point Dam may block fish at certain flows. Three water diversion facilities are at or near the dam. It was originally built to retain hydraulic mining debris and now has no appreciable water storage because it is filled with sediment. According to John Nelson, DFG Region II, the three diversions generally extract water from late March through January with potential diversion rate exceeding 1,085 cfs. Daguerre Point Dam has two fish ladders on opposite ends of the dam which are functional within a narrow range of flows for optimal fish passage. Additionally, stored gravels upstream of the dam periodically block the exits of the fish ladders. This gravel must be excavated to allow any fish to fully ascend the ladders.

General Description

The Yuba River originates on the western slope of the Sierra Nevada at an elevation of about 8,200 feet. It flows westerly about 77 miles to its confluence with the Feather River near the town of Marysville. Rainfall and snowmelt are the major sources of water in the watershed. Annual precipitation ranges from a low of 30 inches in the western part of the watershed, to a high of about 80 inches in the northern and southeastern portions of the drainage (PG&E 1989). The river drains about 1,339 square miles with a total storage capacity of 1,377,000 acre-feet. The upper portion of the Yuba River Basin is drained by the north, middle, and south forks, which join upstream of Englebright Lake to form the mainstem of the Yuba River.

Fish Populations

Historically, the Yuba River supported 15 percent of the annual fall-run Chinook salmon in the Sacramento River system (Yoshiyama and others 1996). A total of 77 miles of the river was accessible to fall-, late fall-, and spring-run Chinook salmon and Central Valley steelhead. Now, only 24 miles are accessible to these species (NMFS 2000).

The Yuba River historically supported a fall and spring Chinook salmon run. The spring-run extended into the North Fork , perhaps as far upstream as Sierra City; the Middle Fork near the confluence with the North Fork; the South Fork perhaps as far upstream as Poorman Creek; and Dry Creek at least 5 to 6 miles upstream from its confluence with the Yuba River. The fall-run likely migrated as far as Downieville on the North Fork, up the Middle Fork near the confluence with the North Fork; within 1 to 2 miles of the mouth of the

South Fork; and up Dry Creek at least 5 to 6 miles According to unpublished and undated Department of Fish and Game files, steelhead were observed near Downieville on the North Fork and probably ascended as far upstream as Love Falls; Bloody Run Creek on the Middle Fork; Poorman Creek on the South Fork; and Dry and Deer Creek on the mainstem (Yoshiyama and others 1996).

DFG has conducted fall-run Chinook salmon surveys from 1953 to 1989. The Yuba County Water Agency has continued the surveys since 1990. The surveys have been conducted in the major spawning areas, from the Narrows to the Marysville dump, about a mile downstream of Hallwood Boulevard. Fall-run salmon populations have ranged from a high of 39,367 in 1982 to 1,205 in 1957. The 1999 population was 23,049 fish (Grandtab, DFG, Red Bluff Office, contact Colleen Harvey 2000).

A remnant population of spring-run Chinook salmon persists and is maintained by fish produced in the river (DFG 1993). In 1998, Julie Brown, DFG biologist, surveyed spring-run redd distribution counting 105 redds between 15 Sep and 15 Oct.

From 1970 though 1979, DFG planted yearling steelhead from the Coleman National Fish Hatchery. In 1984, the run size was estimated at 2,000 steelhead (DFG 1984 in McEwan and Jackson 1996). It is unknown whether the present steelhead stock is of native origin or is derived from stocking of hatchery fish. In any event, the stock today is managed as a naturally sustaining population and is essentially the only wild steelhead fishery remaining in the Central Valley (McEwan and Jackson 1996).

Water Quality

Existing water quality data were collected and analyzed by DFG for the Yuba River from New Bullards Bar Dam downstream to the confluence with the Feather River. The information was used to describe water quality since 1950. The analysis concluded that the general physical water quality of the lower Yuba River is quite good and well within acceptable ranges for salmonids and other key freshwater biota (DFG 1991). Concentrations of some minor or trace elements infrequently exceed USEPA (1986) criteria, and detectable concentrations of some pesticides and industrial chemicals have been found in water, fish tissue, or sediment samples but not at levels considered unsafe or harmful to freshwater biota (DFG 1991).

Low flows and elevated water temperatures resulting from water diversions have affected anadromous populations of the lower Yuba River (DFG 1991). Potential effects of water temperatures on anadromous fish were assessed by DFG by comparing thermal preferences of each species' life stage to existing temperatures in the lower Yuba River, below Englebright Dam, during the water years from 1973 through 1978. Preferred spawning temperatures range from 40°-57° F for Chinook salmon. DFG found in-river temperatures at Marysville to be near or above 57° F until after mid-October and regularly into November. Optimum instream temperatures for juvenile rearing, ranges from 53° to 56° F for Chinook salmon and 55° to 60° F for steelhead. DFG found water temperatures near Marysville may often exceed preferred juvenile Chinook salmon rearing temperatures by early April, and, by June, even water that is released from Englebright Dam may exceed the preferred ranges (DFG 1991).

In 1991, DFG requested the SWRCB revise existing streamflow and temperature requirements on the lower Yuba River in accordance with recommendations set forth in the Lower Yuba River Fisheries Management Plan (DFG 1991). A 1992 SWRCB draft decision was not acted upon and a subsequent hearing in 2000 resulted in revised instream flow requirements. The decision requires some specified actions to provide suitable water temperatures for anadromous fish and to reduce fish losses at water diversion facilities, however it states it is not always feasible to achieve suitable water temperatures for protection of salmon and steelhead. Temperature problems remain a concern under certain conditions and flows.

Hydrology

The monthly mean flow for the gage station in Marysville on the Yuba River is 2,341 cfs. Flows range from 833 cfs during the summer to 4,740 cfs during the winter and spring.

Streamflow and water temperature records are available from a USGS gaging station on the Yuba River about 4.2 miles northeast of Marysville. Streamflow records since 1943 are available (USGS 2001).

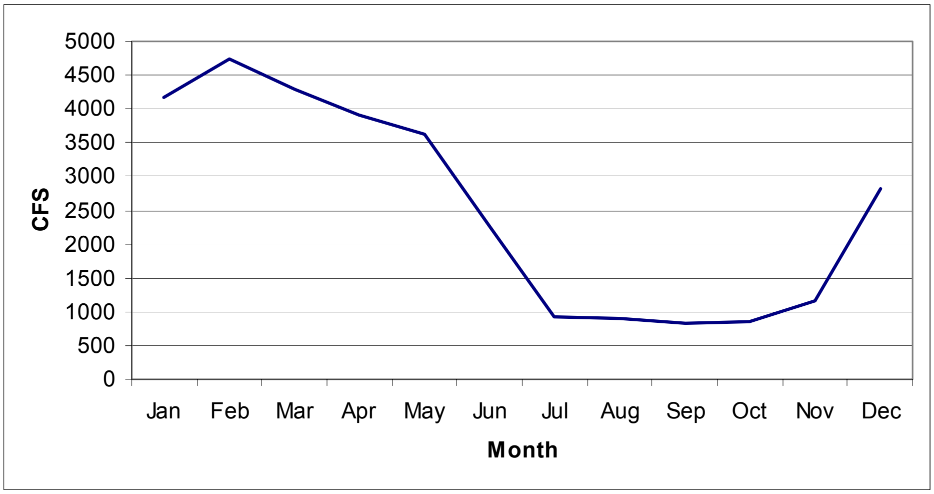

Figure 31. USGS gage station site number 11421000 in Marysville, Yuba County, for the period of 1943 to 2000 (USGS 2002).

Habitat Quality

Hydraulic gold mining, gravel mining, and channelization have disturbed the riparian habitat in the lower reaches of the Yuba River. Downstream of Daguerre Point Dam, the river is comprised primarily of alternating pools, runs, and riffles with a gravel and cobble substrate that is suitable for salmon spawning under adequate flows and temperatures (CH2MHill 1998).

The habitat upstream of Daguerre Point Dam has a higher ratio of pool to riffles, more frequent spawning gravel, and more shaded riverine aquatic habitat than that downstream of the dam (USFWS 1995).

The lower 500 feet of Deer Creek, a tributary below Englebright Dam, provides suitable spawning habitat, but waterfalls block the passage of salmon. However, steelhead trout have been found above the falls during wet years (DFG 1991).

Dry Creek enters the Yuba River about 10.3 miles downstream of Englebright Dam. Mearle Collins Reservoir regulates the stream flow in this creek. Steelhead and fall-run Chinook salmon are known to use Dry Creek (CH2MHill 1998).

Habitat Data

Beak Consultants performed an instream flow study on the lower Yuba River for DFG. The results indicated that weighted usable area (WUA) is highest for spawning Chinook salmon at 600-700 cfs. Thus, when fall flows in the lower Yuba River drop below 600 cfs, spawning habitat becomes limited (USFWS 1995).

Riparian vegetation along the Yuba River was mapped from 1996 to 1998 by California State University, Chico, Geographic Information Center, as part of the Sacramento River Stream Corridor Protection Program and is available from CSUC as an ArcView project file.

Fisheries and Restoration Projects

A study evaluating the potential for decommissioning Englebright Dam was completed 30 Oct 1999. Availability and suitability of habitat, water temperature modeling, and sediment quantity and quality studies were conducted. The lead agency in that project was the South Yuba River Citizens League (Ward 1997).

The Narrows project, lead by PG&E for FERC relicensing requirements, began in 1995 and is expected to continue until 2025. The purpose of this project is to enhance anadromous fisheries in the lower Yuba River through habitat improvement and restoration, fish screening alternatives at diversions, sediment management, and improved fish passage at dams (Ward 1997).

The Anadromous Fish Restoration Program funded a 1998 preliminary engineering evaluation for development of barrier structures to prevent access of anadromous fish into the goldfields. In 1999, AFRP funded a project to develop fish screen and diversion bypass feasibility alternatives at the Hallwood-Cordura Irrigation District Diversion (USFWS 1998).

In 1999, the U.S. Fish and Wildlife Service (USFWS) funded a U.S. Army Corps of Engineers (USACE) Preliminary Fish Passage Improvement Study of fish passage alternatives at Daguerre Point Dam (USACE 2001).

Initiated in 2001, DWR and the Corps are preparing a joint draft EIR/EIS to evaluate the Daguerre Point Dam Fish Passage Improvement Project on the Yuba River. The project has a goal to improve upstream and downstream fish passage for native anadromous fish species at the dam and contribute to overall population recovery for the spring-run Chinook salmon and steelhead.

The Yuba River Temperature Monitoring Project report was prepared for USFWS and distributed in February 1999. Water temperatures were monitored in the main stem Yuba River, north fork, middle fork, and the south fork from the headwater reservoirs to the confluence with the Feather River during the summer of 1998. The object of that report was to provide an initial basinwide estimate of thermal diversity in the Yuba River watershed under spring and summer conditions (USFWS 1998).

DFG and AFRP are funding the Yuba River Chinook salmon and steelhead life history evaluation. Rotary screw traps are installed on the Yuba River at Hallwood Boulevard, about 6 miles upstream of Marysville. The sampling location covers about 18 miles of spawning habitat. The objectives of the project are to document timing of emergence, size and condition at emigration, duration of emigration, and a measure of abundance (USFWS 1998).

The Lower Yuba River Technical Working Group is also supporting the development of a long-term restoration planning document to assist in prioritizing actions to complete restoration and enhancement of salmonid habitat, according to Ted Frink, DWR Fish Passage Improvement Program.

Lower Sacramento River and Delta Tributaries

Cosumnes River, Sacramento County

Potential Impediment to Anadromous Fish Migration

In most years Latrobe Falls, a natural barrier to upstream migration, restricts anadromous fish to the lower 41 miles of the mainstem Cosumnes. In extremely wet years a second channel forms around the falls and fish have access to 11 more miles of the stream before they are stopped by another natural barrier (CH2M Hill 1998). Below Latrobe Falls there are five dams and one road crossing which present barriers to migration at low flows.

General Description

The Cosumnes River watershed drains 550 square miles from its headwaters in the Eldorado National Forest in the western Sierra Nevada to its confluence with the Mokelumne River north of Thornton at the Sacramento-San Joaquin County line. The mainstem Cosumnes is 41 miles long below its three upper forks (USFWS 1998). The river is not only fed by rain runoff but also receives a fair amount of snowmelt due to the elevation of its headwaters around 8,000 feet. The Cosumnes River drops to an elevation of 5 feet at its confluence with the Mokelumne River at River Mile 38 (USBR 2000).

Fish Populations

The Cosumnes River has historically supported a run of fall-run Chinook salmon. One 1929 historical document referenced in Yoshima and others (1996) called the salmon run on the Cosumnes "a considerable run," and run size estimates of less than 500 to 5,000 fish exist for the period 1953-1959. Historically, the run size has averaged about 1,000 fish, but recent runs have numbered fewer than 100 fish (DFG 1993). Fall-run Chinook salmon spawn in the Cosumnes River between Meiss Road and Michigan Bar Road. The size of the run varies greatly from year to year and is largely dependent on the flow in the river. Adult salmon are in the river from mid-November through mid-January. Juveniles are usually observed from February through May.

The state Department of Fish and Game (DFG) conducted annual spawning surveys of the river from 1953 to 1989. Population estimates based on those surveys ranged from zero to 5,000 fish with an average of 1,300 fish (USBR 2000). In December 1997, Keith Whitener, project ecologist with the Nature Conservancy, published an assessment of the salmon run on the Cosumnes River, which included spawner surveys and redd surveys of the area between Michigan Bar and Meiss Road (Whitener 1998). Also in December 1997, DFG conducted an aerial photography redd survey of the river in the same area. This survey found about 209 redds (Snider and Reavis 2000). Based on these two surveys, the 1997 population of fall-run Chinook salmon was 300 to 500 adult fish. A 1998 spawner escapement survey conducted by Whitener produced an estimate of between 250 and 450 fish (Whitener 1998). DFG and the Nature Conservancy did a spawner escapement survey in 1999 that resulted in a DFG estimate of 250 to 350 spawners in the river between Meiss Road and Latrobe Falls. In some years DFG plants salmon from the Nimbus Hatchery in the Cosumnes River. In 1996, 225,000 fry were planted and may have contributed to the 1998 spawning population (Snider and Reavis 2000; Kennedy and Whitener 1999).

The Cosumnes River is designated as critical habitat for Central Valley steelhead and, according to Harris (1996), a 1994 DFG survey identified steelhead smolts in the lower Cosumnes. However, no steelhead run has been documented on the Cosumnes. High summer temperatures in the river and a natural barrier to migration at RM 42 probably preclude a sustainable run of steelhead (USBR 2000).

Water Quality

Flow and temperature are the two major water quality issues on the Cosumnes River, which adversely affect migrating salmon. Water temperature in the Cosumnes River often reaches levels that are lethal to young salmon by mid-spring. (USFWS 1998) Temperature data was collected near Michigan Bar Road from October 1998 to October 1999 in conjunction with a DFG spawner escapement study. From March through June the temperature ranged from 45° F to 78° F. Salmon catches dropped to zero during the escapement survey when water temperatures reached 65°F in early July even though flows were in excess of 200 cfs. This indicates that escapement is related to temperature (Snider and Reavis 2000). Temperature data was collected for the upper reaches of the river in 1994 during a DFG stream survey and in 1995, during a related fish and channel description (DFG 1994; DFG 1995).

Hydrology

The first and most severe problem is the lack of flow in the lower reaches of the river, especially in dry years. There is a USGS gage at Michigan Bar Road and data from it is available for the past 95 years. In the summer of most normal and dry water years, the flow between Highway 99 and Twin Cities Road is often completely subsurface. This is largely due to agricultural diversions. During the peak of the irrigation season there is often no flow below the Meiss Road Bridge. Observations during dry years suggest that flows of 40-70 cfs are required at Michigan Bar Road in order to achieve continuous flow in the lower reaches of the river (USBR 2000). Anadromous fish must wait for fall rains to water the river channel before they can begin their migration. Flows of at least 80-100 cfs are required for fish passage over the low flow barriers in the river (Whitener 1998). In normal to dry years, flows that high may not occur until well into the spawning season. Results from a 1998-1999 salmon spawner survey indicate that salmon do not begin spawning in the Cosumnes River until flows reach 200 cfs. In 1998, flow did not reach 200 cfs until November 24 and flows dropped to 138 cfs by December 23 (Snider and Reavis 2000). In years of low rainfall, no fish spawn in the Cosumnes River because adequate flows are not present until after the spawning season (USFWS 1998). Spring flows are usually adequate for out-migration of juveniles (DFG 1990).

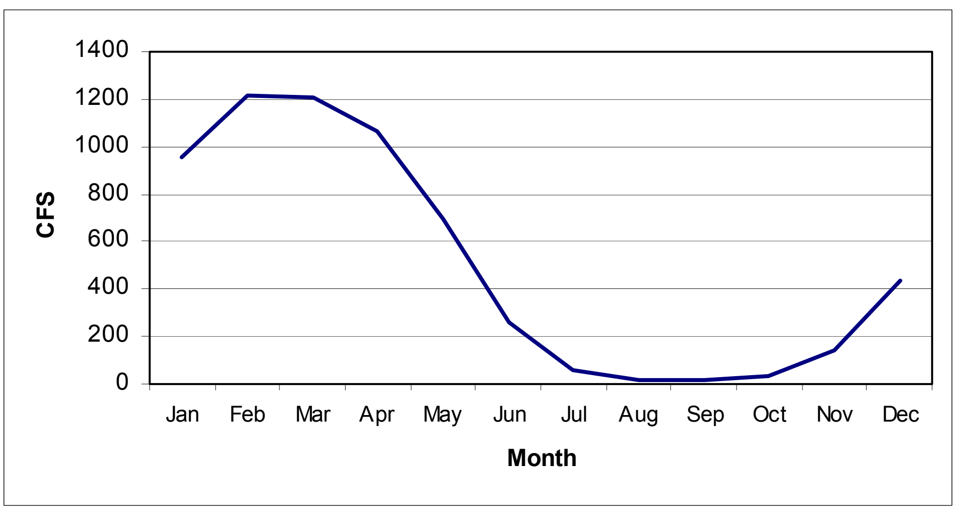

Figure 32. USGS gage station site number 11335000, at Michigan Bar Rd, Sacramento County. Graph generated from data received from 1907 to 2002 (USGS 2002).

The USGS has collected flow data at Michigan Bar from 1907 to the present (USGS 2001). According to the mean flow data taken at Michigan Bar Road gage station, flows during the summer reach flows as low as 15 cfs. These flows are well below the recommended flow needed for spawning. During winter and spring, flows reach a maximum of 1,214 cfs, which is more than sufficient for recommended flows for spawning salmonids.

Habitat Quality

At higher elevations, the Cosumnes River and its tributaries are bordered by Sierra mixed conifer forest. As the river descends to the Central Valley, it traverses oak woodland, chaparral, annual grassland, and agricultural land. Along the lower reaches of the river between Interstate 5 and Highway 99, dense riparian forests of willow, cottonwood, valley oak, and white alder are present (USFWS 1998). Sediment and lack of gravel are a problem in the Cosumnes River below River Mile 31.6; however, above that there is good spawning habitat. The reach below Granlees Dam is described as "an example of excellent gravel bars that contained many redds" in an assessment done by Keith Whitener (1998). Another report states that the spots with the best spawning gravel also have extensive stretches of willow/cottonwood corridors (USFWS 1995). And during a 1998-1999 survey, water clarity exceeded 6 feet in the reach between Michigan Bar Road and the Meiss Road Bridge where most spawning takes place (Whitener 1998). Below the spawning area, reaches have been denuded by livestock, and fine sediment has infiltrated the gravel, making it unsuitable for spawning (USFWS 1998).

Habitat Data

Bioassessments of the creek were done in 1994 and 1995, which included electrofishing to determine what species of fish are present, temperature measurements, streamflow measurements, and descriptions of the channel and its banks. This bioassessment was done at points beginning at Michigan Bar and continuing up the mainstem Cosumnes to Highway 49, up the north fork to Camp Creek and up the middle fork to Peddler Creek (DFG 1995). There is also gravel and flow information for 1956 (Westgate 1956).

Fisheries and Restoration Projects

The Fishery Foundation of California is working on a project to modify three of the five barriers on the Cosumnes River. In 2000, a box culvert was constructed under a road that was a low flow barrier. There are two fish ladders on Granlees Diversion Dam that are only functional at high flows. The Fishery Foundation will modify the ladders so that they are functional at a wider range of flows. In 2003, the foundation will install a rock weir fish ladder at Hopland Ranch Dam that was previously unladdered. The estimated cost of these projects is $376,510 (USBR 2000).

Fish passage improvement at Blodgett Dam is planned in conjunction with reconstruction of the dam by the dam owner, Omochumnes Hartnell Water District. The project was completed in fall 2002 using funds from flood damage insurance through the Federal Emergency Management Agency.

Dry Creek, Placer County

Potential Impediments to Anadromous Fish Migration

Dry Creek and its upstream tributaries have four dams and three pipeline crossings that potentially impede anadromous fish migration from the confluence with Natomas East Main Drainage canal to the upper watershed.

General Description

Dry Creek originates in the Sierra Nevada foothills northwest of Folsom Lake. This basin is drained by Antelope Creek, Miners Ravine, and Secret Ravine, which join northeast of Roseville to form Dry Creek. Dry Creek connects with Cirby Creek, and then continues its course to Rio Linda where it joins the Natomas East Main Drainage Canal. The canal flows into the Sacramento River just north of the confluence of the American River with the Sacramento River. The drainage encompasses about 100 square miles.

Fish Populations

Historically, Dry Creek and its tributaries have supported fall-run Chinook salmon and steelhead trout from the American Basin. The American Basin has since been drained and replaced by the Natomas East Main Drainage Canal. Historical data is sketchy for Chinook salmon. However, Gerstung (1964) estimated runs of 600 for Secret Ravine as well as 1,000 for the Dry Creek watershed for 1963. There are no significant records of historical distribution or abundance for steelhead trout in the Dry Creek drainage (Hallock 1989, as cited by Li and Fields 1999).

Currently fall-run Chinook salmon are found in the upstream tributaries (Antelope Creek, Miners Ravine, and Secret Ravine). The extent of upstream migration in the tributaries includes Antelope Creek just above Highway 65; Miners Ravine creek at the town site of Hidden Valley; and Secret Ravine creek at Rock Springs Road (NMFS 28 Nov 2000).

Fish counts have been performed by the Dry Creek Conservancy for the past four years, according to Gregg Bates, director of the Conservancy (Bates October 18, 2000). The Dry Creek Conservancy observed 67 live salmon and 13 carcasses in a portion of Secret Ravine between 11 and 13 Nov 2000. Bates reported (Bates November 15, 2000) that salmon were also observed in Antelope Creek, Linda Creek, Miners Ravine, and Dry Creek. DFG has conducted juvenile anadromous fish sampling in 1999 and 2000 although this information has not yet been released.

Water Quality

Water quality concerns are primarily related to excessive sand being washed down the tributaries of Dry Creek, reducing the quality of riffles and the depths of pools. This has, in turn, degraded spawning and rearing conditions for salmonids and reduced invertebrate populations that are essential for salmonid food supply (Vanicek 1993). The water quality can also be affected by discharges from the Roseville sewage treatment plant southwest of Roseville.

Water temperatures can be variable depending on precipitation. The watershed is not at a high enough elevation to receive snowmelt that would buffer higher stream temperatures. Increased water temperatures can delay or prevent salmonid migration. Less favorable water temperature conditions for juvenile steelhead trout have been observed downstream of the confluence of Secret and Miners Ravines (DFG 1998).

Hydrology

Streamflow data for Dry Creek is limited. USGS operated a gage near Roseville from 1963 to 1967 (USGS 2002). Mean flow for years of record range from non-existent to 0.85 cfs. Annual peak flows were recorded by USGS from 1960 to 1973 (USGS 2002). Annual peak flows ranged from 16 cfs on 5 Feb 1972 to 220 cfs on 9 Feb 1962.

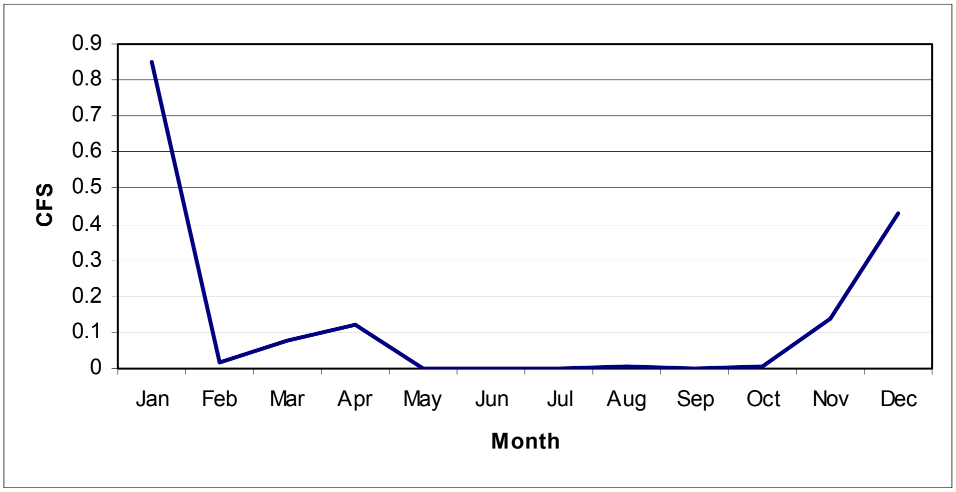

Figure 33. USGS gage station site number 11447300, Dry Creek tributary near Roseville. Graph represents mean flow data received from 1963 to 1967 (USGS 2002).

Habitat Quality

Habitat quality is generally poor within the lower reaches of Dry Creek. There are few pools and few riffles and there is an excess of sand and silt. The upper tributaries (Miners Ravine and Secret Ravine) provide habitat described as good to excellent (Vanicek 1993). The upper tributaries, however, are being impacted by the excessive downward migration of sand due primarily to erosion. The sand is covering the spawning gravels and creating shallower pools. Rearing habitat for salmon, steelhead, and aquatic invertebrates has been degraded in the downstream areas resulting in poor rearing conditions for juvenile salmon during spring (Vanieck 1993). The lack of holding pools and the presence of barriers at low flows impact the upstream migration of adult salmon in the lower reaches of the Dry Creek habitat. (Vanicek 1993).

The riparian habitat quality in Dry Creek and its tributaries ranges from "exceptional" to "severely encroached upon." Continuing development is causing severe impacts on riparian habitat and flood control (Bishop 1997).

The benthic macroinvertebrate fauna studied in Secret Ravine were found to be in fair condition in terms of species diversity (Fields 1999).

Habitat Data

A fisheries habitat evaluation was prepared for Dry Creek and its tributaries by C. David Vanick in 1993. Additional studies have been conducted on Secret Ravine including a hydrology and geomorphology study prepared by Swanson Hydrology and Geomorphology (Swanson 2000); a stream habitat assessment prepared by Stacy K. Li (Li and Fields 1999); a vegetation analysis prepared by Robert F. Holland (Holland, 2000); and a benthic macroinvertebrate fauna analysis prepared by Wayne C. Fields Jr. (Fields 1999). In addition, an evaluation of Dry Creek and its major tributaries was completed by Debra Bishop in 1997. This evaluation contains extensive riparian habitat descriptions of various reaches of Dry, Antelope, Cirby, and Linda Creeks as well as Miners, Secret, and Strap Ravines (Bishop 1997).

Fisheries and Restoration Projects

Habitat improvement projects have focused on Secret Ravine and Miners Ravine as these two tributaries account for most of the available spawning and rearing habitat (NMFS 2000). Upper Dry Creek has also been the focus of restoration efforts.

A habitat survey is being prepared for Secret Ravine funded by the US Fish and Wildlife Service Anadromous Fish Restoration Program (USFWS-AFRP). It includes habitat mapping, water-temperature monitoring, spawning habitat assessment, macroinvertebrate surveys, riparian vegetation, soil and sedimentation evaluation and will include priority actions to restore anadromous fish resources. It was due for completion in 2001.

On 18 Feb 1992, Mitchell Swanson and Associates prepared a study titled "The Miners Ravine Watershed Enhancement and Restoration Plan for the Reduction of Flood Hazards and the Enhancement and Protection of Environmental Resources." It was done for the Granite Bay Community Association through the Department of Water Resources Urban Creek Restoration Program. The management plan addresses environmental, drainage and erosion issues for the Miners Ravine watershed (Swanson 1992).

USFWS-AFRP is funding the Dry Creek Conservancy to coordinate with the Dry Creek Coordinated Research Management and Planning, property owners, and necessary agencies to development an adaptive management strategy for the Dry Creek watershed. The object is to restore Chinook salmon and steelhead habitat and involve creekside homeowners in the implementation and evaluation of restoration actions. The completion date for the strategy was September 2001.

The Dry Creek Conservancy placed 200 cubic yards of spawning gravel in Secret Ravine in fall 2000, according to G. Bates of the Dry Creek Conservancy.

Placer County will use Proposition 204 grant funds in 2001 - 2003 for various projects such as watershed planning, a monitoring program to supplement the existing Dry Creek Conservancy program, and a stream bank stabilization and revegetation project on Miners Ravine.

An Urban Streams Restoration Grant from DWR was used in 2000 by the Dry Creek Conservancy for restoration purposes on Dry Creek where it flows through Royer Park in downtown Roseville.

Lower Sacramento River, Downstream of Feather River

Potential Impediments to Anadromous Fish Migration

No physical barriers exist in the Sacramento River from San Francisco Bay to the Feather River. There is a lock at the upper end of the Sacramento River Deep Water Ship Channel at the connection to the Sacramento River. This lock blocks the migration of all fish from the deep water channel back to the Sacramento River. The locks are no longer operated for shipping purposes.

Floodwater diversions into the Sutter and Yolo Bypasses can subject Chinook salmon to potential upriver and downriver migration delays. The weirs on the banks of the Sacramento River can act as barriers and block the passage of fish. Fish can also be trapped in the bypasses as floodwaters recede (USFWS 1995).

General Description

The Sacramento River Basin covers nearly 27,000 square miles, making it the largest river system in California. The river's tributaries stretch into the Sierra Nevada, the Coast Range, the Cascade Range and the Modoc Plateau, with headwaters emanating from above 10,000 feet elevation. California's premier river conveys about a third of the state's natural runoff and provides a wide range of recreation and water-related benefits that enrich the entire state. The Sacramento River system contributes greatly to the state's and Pacific Northwest's sport and commercial salmon fishing industries, producing more than 70 percent of the salmon caught off the California coast (Resources Agency 1989). The following pertains primarily to the Sacramento River below the Feather River

Fish Populations

Historically, the Sacramento River supported runs of fall-, late-fall, spring-, and winter-run Chinook salmon, all of which migrated through the lower Sacramento River to reach historical spawning grounds in the upper watershed (Yoshiyama and others 1996). Steelhead trout were also prevalent in the higher Sacramento River watersheds (USFWS 1995). Today, the Sacramento River supports fall-, late-fall, winter-, and spring-runs (DFG 1993; NMFS November 28, 2000). Steelhead trout are also present in the Sacramento River (McEwan and Jackson 1996).

Population estimates for Chinook salmon runs are only available for the upper portion of the Sacramento River and for Sacramento River tributaries such as the Feather River and American River based on counts performed at tributary hatcheries and at Red Bluff Diversion dam because the lower Sacramento River is primarily a migration corridor (see Habitat Quality, below).

The number of steelhead trout that spawn in the Sacramento River is unknown, but it is probably low. Loss of access to the headwaters has rendered the Sacramento River unsuitable for natural reproduction. (McEwan and Jackson 1996). The average annual total steelhead trout run in the Sacramento River system was estimated by DFG in 1990 to be about 35,000 fish, primarily hatchery produced. Counts of steelhead trout are generally only available from the hatcheries (USFWS 1995).

DFG has also been studying the emigration of juvenile salmonids for the past several years. The study is based on a rotary screw trap placed at Knights Landing with mean trap efficiencies ranging from 0.8 to 1.45 percent. Relative abundance figures for the fall run were 5,161,417 in 1996, 2,667,679 in 1997, and 8,458,150 in 1998. The number of fish emigrating through the Sutter Bypass is unknown; therefore, the number of fish migrating through the Delta is unknown. (Snider and Titus 1998 and 2000)

Water Quality

The Sacramento River Watershed Program monitors water quality characteristics including metals, PCBs, pesticides, and pathogens (Sacramento River Watershed Program 2000). The Sacramento River carries the pesticide diazinon, and the heavy metals mercury, cadmium, copper, and zinc.

The Colusa Basin Drainage Canal discharges agricultural drain water into the Sacramento River at Knights Landing and at the Yolo Bypass toe drain. This agricultural runoff, which is several degrees warmer than the river, increases the river temperatures (McEwan and Jackson 1996). The drain also blocks access to most westside streams, which during some years can provide excellent spawning and early season rearing habitat. (DFG 1993)

Hydrology

For water year 1999, the flow varied from 12,700 to 86,700 cfs (daily mean value). For period of record (since Oct. 1948), maximum discharge was 117,000 cfs and minimum daily discharge was 3,970 cfs (USGS 2000).

Mean flows for summer reach a low of 10,070 cfs. Winter and spring flow values indicate very high flows up to 34,750 cfs. Annual mean flow for the gage station at Verona is 19,428 cfs. According to these values, salmonids have adequate flow for immigration and emigration throughout the year.

USGS maintains a hydrologic data station on the Sacramento River at Freeport. Available data includes flow (since 1948), temperature (since 1960), and suspended sediment (since 1956). Other data such as water quality are measured at various times (USGS 2000).

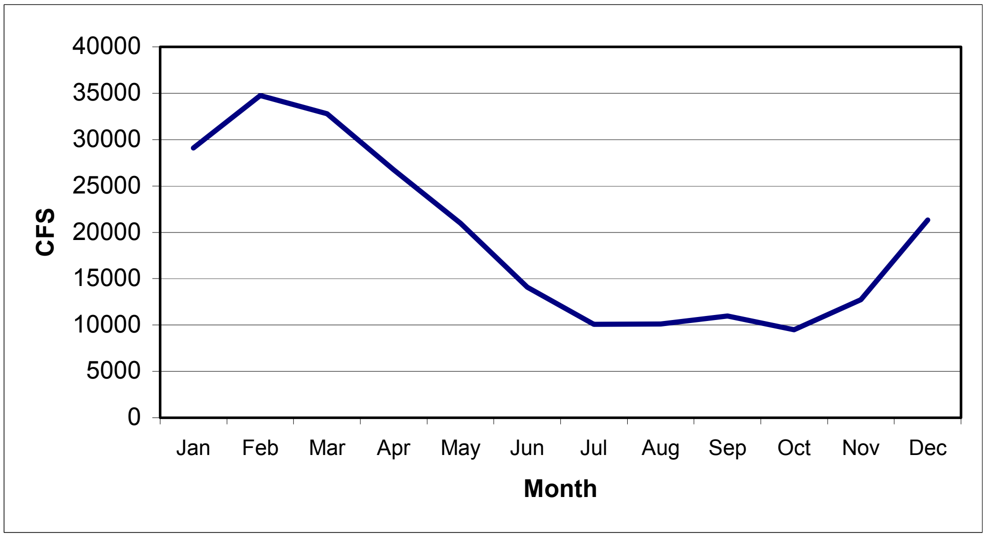

Figure 34. USGS gage station site number 11425500 at Verona, Sutter County. Graph represents mean data values taken from gage from 1929 thru 2000 (USGS 2002).

Habitat Quality

Salmon spawning and rearing primarily occurs in the Upper Sacramento River. Fish migrate through the lower Sacramento River to the upper Sacramento River and its tributaries for spawning and rearing (NMFS 2000). The downstream limit of suitable water temperatures for spawning of fall-run Chinook salmon is generally near Hamilton City. Suitable spawning temperatures for winter- and spring-run salmon are generally limited to the reach above Red Bluff Diversion Dam (USFWS 1995). Water temperature has a larger impact on steelhead trout than salmon due to their longer rearing periods in the stream. Summer temperature conditions in the low-elevation reaches below dams can be very hostile to rearing steelhead trout. Spring-run Chinook salmon, with a longer rearing requirement, are similarly affected (McEwan and Jackson 1996).

Riparian vegetation has been significantly reduced along the Sacramento River. Existing riparian woodland along the Sacramento River is less than 5 percent of its historical acreage and river edge vegetation is less than 50 percent of its historical extent (The Resources Agency 1989 as cited in USFWS, 1995). About 5 percent to15 percent of historical acreage remains on tributary streams (Mills and Fisher, 1993 as cited in USFWS, 1995). Loss of riparian vegetation has been most severe on the Lower Sacramento River and Delta (USFWS, 1995).

The Lower Sacramento River has also been extensively channelized, resulting in a narrower, deeper channel. The construction of levees and installation of rock riprap for bank stabilization purposes has caused an extensive loss of shaded riverine aquatic habitat (USFWS 1995). Gravel recruitment in the Lower Sacramento River occurs primarily from natural erosion of natural deposits on the banks of the Sacramento River. Gravel recruitment has been substantially reduced in these areas due to bank protection and levee construction. (Buer and others 1984, as cited in USFWS, 1995).

Habitat Data

Riparian vegetation along the Sacramento River was mapped between 1996 and 1998 by California State University, Chico, Geographic Information Center as part of the Sacramento River Stream Corridor Protection Program and is available from CSUC as an ArcView project file.

The Sacramento River Watershed Program monitors water quality in the Sacramento River and several tributaries (Sacramento River Watershed Program 2000).

Fisheries and Restoration Projects

The primary issue being addressed in the Lower Sacramento River is fish passage through the Yolo Bypass and the Sacramento Deep Water Ship Channel. A topographic survey of Yolo Bypass, just below the Fremont Weir, was completed in 2000 by DWR to evaluate fish passage options at the weir. Fremont Weir is being considered as a pilot project along with fish passage at the Sacramento Deep Water Ship Channel in a study led by DWR. Habitat restoration is also being addressed although this issue is more complex because much of the lower Sacramento River is channelized and constrained by levees.

The Sacramento and San Joaquin River Basins Comprehensive Study is being prepared by the U.S. Army Corps of Engineers, the State of California Reclamation Board, and various other federal and state agencies. This study will address flooding and environmental restoration issues and may be completed by fall 2002.

The CVPIA Anadromous Fish Restoration Program is providing funding for fish screen design and construction at irrigation pump intakes along the lower river and into the Sacramento-San Joaquin Delta.

Murphy Creek, Amador and San Joaquin Counties

Potential Impediments to Anadromous Fish Migration

Sparrowk dam is an 8-foot-high earthen dam that is a complete barrier to anadromous fish passage. The Buena Vista Road Bridge impedes fish passage at low flows.

General Description

Murphy Creek is a tributary of the Mokelumne River that traverses Amador and San Joaquin Counties, entering the Mokelumne River about 0.3 of a mile below Camanche Dam, which is on river mile 63 of the Mokelumne River. Murphy Creek is about 6 miles long and its total watershed is about 5 square miles, ranging in elevation from 300 feet at its headwaters to 100 feet at its confluence with the Mokelumne River.

Fish Populations

Adult Chinook salmon were observed swimming past and spawning in habitat above the lowest reservoir during a dam failure in the mid to late 1980s (EBMUD 2002). No salmonid spawning has been documented within Murphy Creek since that time. However, EBMUD (2002) performed fish surveys and juvenile Chinook salmon and steelhead were observed in the lower reaches of the creek in the spring of 2000.

Water Quality

Water temperature and dissolved oxygen levels were measured by EBMUD (2002). Dissolved oxygen levels in non-reservoir habitats ranged from 6.16 mg/L in pool habitat to 9.91 mg/L in riffle habitat.

Hydrology

There are no USGS or DWR stream gages on Murphy Creek. No hydrology data is available. Field observations indicate continuous flows occur in the creek possibly supplied or augmented by lateral seepage from adjacent Camanche Reservoir.

Habitat Quality

EBMUD (2002) found that substrate within the middle reaches of Murphy Creek is suitable for Chinook salmon and steelhead spawning and a preliminary study of hatchery Chinook salmon eggs survival suggests that successful hatching of alevins is possible. Livestock access and lack of canopy on most of the middle and lower portions of Murphy Creek may adversely impact spawning and rearing habitat for salmonids (EBMUD 2002).

Habitat Data

Pebble counts and benthic macroinvertebrate surveys were conducted by EBMUD (2002).

Fisheries and Restoration Projects

EBMUD, local landowners, and DWR' Fish Passage Improvement Program are working on a project that will improve fish passage along Murphy Creek. This project will remove one impoundment providing water for livestock grazing, and develop a well in the vicinity of the existing impoundment to provide water to a stock watering tank. The proposed project is funded by grants from the CALFED Bay-Delta Program ($282,500), the National Fish and Wildlife Foundation ($95,000), the U.S. Fish and Wildlife Service's Anadromous Fish Restoration Program ($10,000), and in-kind services from EBMUD ($115,000) and the California Department of Water Resources Fish Passage Improvement Program ($100,000). In addition, fish passage during low flows will be improved at the Buena Vista Road Bridge over Murphy Creek by removing about 60 square feet of the existing concrete ford below the bridge. EBMUD, the landowners, and DWR also plan to increase native vegetation canopy and shrub cover, reduce non-native plant species, and limit livestock access to riparian zones by constructing and maintaining fences and gates to control livestock access.

Putah Creek, Yolo, Napa and Lake Counties

Potential Impediments to Anadromous Fish Migration

At River Mile 30, Monticello Dam creates Lake Berryessa with a capacity of 1.6 million acre-feet. This dam is an absolute barrier to anadromous fish passage in Putah Creek. There are four dams (including Monticello Dam) and one road crossing on Lower Putah Creek, which impede fish migration. The bypass check dam and the road crossing are seasonal barriers, which are impediments to migration when they are in the creek, but they are generally removed before upstream migration begins. The town of Winters' Percolation Dam is the unused remains of an old dam. This dam is passable at certain flows but it is not clear what those flows are. Putah Diversion Dam and Monticello Dam (Solano Project dams) are both unladdered and impassable at all flows.

General Description

Putah Creek is 80 miles long and drains 810 square miles from its headwaters in the Mayacmas Mountains to its confluence with the Sacramento River. Putah Creek begins at an altitude of about 4,300 feet and drops to 100 feet as it reaches the Sacramento Valley. The 30-mile section of the creek below Monticello Dam is referred to as Lower Putah Creek. Only Lower Putah Creek is discussed in this river summary.

Fish populations

Historically, all 80 miles of the creek were accessible to anadromous fish. Today, only the lower 24 miles are accessible. All 30 miles of Lower Putah Creek are designated critical habitat for Central Valley steelhead by National Marine Fisheries Service (Putah Creek Council 2000a). There is evidence of historic anadromous fish species in Putah Creek. According to archeological and ethnographic research done by Schultz (cited in Trihey and Associates 1996) the Patowin people harvested Chinook salmon and sturgeon from Putah Creek through the late prehistoric period. A historic document by Shapovalov in 1947 states that both King salmon and rainbow trout were present in Putah Creek. There is also anecdotal evidence of steelhead being caught in Putah Creek as late as 1984. Angler Hal Janson testified at a 1996 trial that he caught salmon and steelhead below Monticello Dam in the late 1960s and early 1970s. In conjunction with the trial, Gary Falxa, Ph.D., a wildlife biologist and ecologist, reported seeing and rescuing stranded steelhead in a Putah Creek tributary in 1984 (Putah Creek Council 1999a).

The Native Species Recovery Plan for Lower Putah Creek, California, cites sampling of the creek by University of California, Davis, professor Peter Moyle and students as evidence of fall-run Chinook salmon in 1975, 1983, and 1995. All three of these years were considered wet years for the creek. Sampling turned up Chinook salmon juveniles in spring 1995 at Dry Creek, Old Davis Road, and Mace Boulevard; in the spring of 1997 at Pedrick Road; and in March 1998 at Mace Boulevard. Spawning also was observed in the winter of 1997-1998 near Stevenson Road Bridge (Marchetti and Moyle 2000). Salmon were also spotted spawning in the creek in March 1999 at Russell Ranch and between Stevenson Road Bridge, Pedrick Road Bridge, and at Mace Boulevard (Putah Creek Council 1999b). A juvenile Chinook was caught in April 2000 (Putah Creek Council 2000). No estimates of run sizes have been made for Chinook salmon or steelhead on Putah Creek.

Water Quality

There are several water quality monitor programs including annual sampling by the Solano Irrigation District, monthly monitoring by the U.S. Bureau of Reclamation, and the Toxic Substance Monitoring Program initiated in 1976 by the State Water Resources Control Board and conducted by the Department of Fish and Game. Past water quality studies include a mineral analysis of surface water quality published in 1955 by the California Division of Water Resources, an analysis of groundwater for common mineral constituents conducted in 1960 by Thomasson and others, and a broad-spectrum analysis of water quality done by Evenson in 1985 (USFWS 1993).

Water flow has been the biggest deterrent to anadromous fish in Putah Creek since 1957 when the Solano Project dams (Monticello and Putah Diversion Dams) were built. Before 1957, Putah Creek was probably intermittent in its lower reaches. Cold water is released from Lake Berryessa via Monticello Dam. In May 2000, the outcome of several legal actions resulted in required releases from Putah Diversion Dam. The agreement specified required amounts and times of water release from the dam to provide water for the benefit of the fish and habitat of Lower Putah Creek. The required flows, to be released and measured directly at the Putah Diversion Dam, are specified by month and range from 20 to 43 cfs in the summer and from 16 to 26 cfs in the winter. The highest flows of 46 cfs are required in April. There are also requirements that flow downstream near the Interstate 80 bridge meet required monthly averages that are slightly lower than required at Putah Diversion Dam. In years designated as drought years, these release requirements are lower in the summer, ranging from 15 to 33 cfs at Putah Diversion Dam. The agreement also established spawning flows to be released from the Diversion Dam for a three-day period between 15 Feb and 31 Mar each year. These flows are 150 cfs for the first day, 100 cfs on second, and 80 cfs on the third. And for the following 30 days, average daily flow at the Interstate 80 bridge must be 50 cfs or greater. The agreement also established a committee to monitor Lower Putah Creek. (Yolo Parties and Solano Parties 2000). Water release statistics for Putah Creek Diversion Dam are available from 1995 to 1999 (Ransom 2000).

Hydrology

Flow data is available from two USGS gages on Putah Creek. One gage, near the town of Guenoc in the upper watershed, has data for the past 49 years. The other gage near the town of Winters has 69 years of data (USGS 2000a, b).

According to these flow values, summer months have relatively low flows down to 2.72 cfs and winter month flows up to 675 cfs with a mean annual flow of 211 cfs.

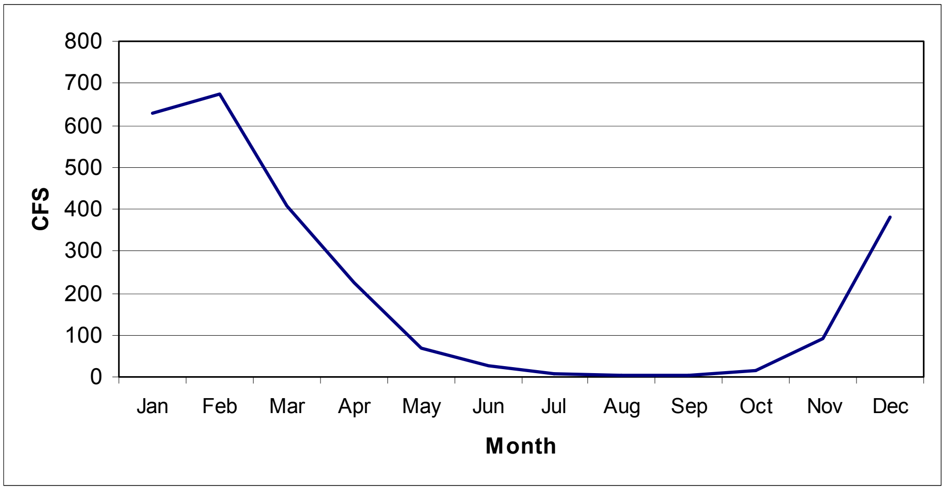

Figure 33. USGS gage station site number 11453500, in the town of Guenoc, Lake County, from 1904 to 2000 (USGS 2002).

Habitat Quality

The riparian zone surrounding Putah Creek has changed drastically in the past 120 years. Many human activities including construction of levees, channel excavation, gravel mining, groundwater extraction, and channel downcutting, have led to a deeper, narrower creek channel. This has decreased the ability of the creek to overflow onto the floodplain. As a result, the existing riparian forest is becoming dominated by valley oak, black walnut, and eucalyptus. Construction of the Solano Project Dams has reduced gravel and sediment recruitment and has decreased the overall dynamics of the creek. Other factors affecting the vegetation along the creek corridor have been loss of land to agriculture, realignment of the channel, incision of the creek and steepening of the banks, dumping of trash and debris into it, burning of the riparian zone, and mechanical vegetation removal for flood control maintenance (USFWS 1993).

The portion of Putah Creek below the diversion dam is "typified by intermittent flowing sections and more permanent deep pools, often formed as a result of beaver activity"(USFWS 1993). More specific habitat surveys of the creek are unavailable. However, there is evidence that it is good rearing habitat for juvenile Chinook salmon. When compared with juvenile salmon in the Cosumnes River, the juveniles in Putah Creek were longer and heartier. This indicates that the fish are doing well in the creek habitat (Ransom 2000). Between Putah Diversion Dam and Monticello Dam there are six miles of good coldwater habitat, according to Joe Krovoza, chairman of the Putah Creek Council.

Habitat Data

There is extensive habitat information available in a USFWS (1993) report to Congress, *Fish and Wildlife Resources Management Options for Lower Putah Creek, California*. Historical fisheries and habitat information is available in a 1947 report by Shapovalov and in the *Native Species Recovery Plan for Lower Putah Creek, California* (Trihey and Associates 1996).

Riparian vegetation along Putah Creek was mapped from 1996 to1998 by California State University, Chico, Geographic Information Center, as part of the Sacramento River Stream Corridor Protection Program and is available from CSUC as an ArcView project file.

Fisheries and Restoration Projects

Now that guidelines for water release down Putah Creek have been established, the political environment is much more conducive to restoration. Most interested parties are willing to work toward a healthier creek ecosystem. Owners of the three downstream barriers are open to the idea of making modifications to existing structures. However, no specific passage improvement projects have been undertaken yet other than establishment of informal protocols for operation of the seasonal check dam in the Yolo Bypass to allow salmon and steelhead passage in the fall. The Putah Creek Council and other groups have undertaken vegetation restoration projects on the creek, primarily tamarisk removal at various sites along the lower creek.

San Joaquin River and Tributaries

Calaveras River, San Joaquin and Calaveras Counties

Potential Impediments to Anadromous Fish Migration

The Calaveras River, Mormon Slough, and the Stockton Diverting Canal have about 26 dams and 15 road crossings that potentially impede anadromous fish migration between the river's confluence with the Delta and New Hogan Dam. Many of the dams are seasonal flashboard dams. FPIP gathered data regarding the size of the structures in 2001, and is now documenting the extent to which these structures impede the passage of anadromous fish under different flow conditions. New Hogan Dam is the upper limit of Chinook salmon migration (NMFS 2000).

General Description

The Calaveras River watershed is on the western lower slope of the central Sierra Nevada. The watershed is about 400 square miles and receives its precipitation as rainfall due to a low elevation. As a result, significant flows enter the river primarily during the late fall, winter, and early spring when precipitation is heaviest. Since the watershed receives little or no snow, river flows in summer and early fall are minimal to nonexistent, and water temperature is warm.

The north and south forks of the Calaveras River join at the east end of New Hogan Lake to form the mainstem of the Calaveras River. After leaving New Hogan Lake, the river continues for about 18 miles to the Bellota diversion structure that divides flow between the Calaveras River and Mormon Slough.

The Calaveras River continues westerly for about 2 miles to the Mosher Creek headgate where Mosher Creek branches off the Calaveras River. Mosher Creek continues westerly, connects to Bear Creek through the Bear Creek check structure, continues its westerly course, and then combines with Bear Creek, which eventually drains into the Delta. The Calaveras River continues its course toward the confluence with the Stockton Diverting Canal. The length of the Calaveras River between Bellota and its confluence with the diverting canal is about 19 miles. The Calaveras River continues westerly from the Stockton Diverting Canal through Stockton where it joins the San Joaquin River.

Mormon Slough continues southwesterly from Bellota and then splits into Mormon Slough and Potter Creek A. Both Mormon Slough and Potter Creek A continue toward Stockton in a parallel alignment. Potter Creek B splits off of Potter Creek A and then returns to the Mormon Slough. Potter Creek C splits off of and returns to Potter Creek A. Potter Creek A continues to its confluence with the Mormon Slough. After an 18-mile run from Bellota, the Mormon Slough connects to the Calaveras River through the Stockton Diverting Canal. The U.S. Army Corps of Engineers built the Stockton Diverting Canal in the early 1900s to divert flows from Mormon Slough to the Calaveras River.

Fish Populations

Historically, the lower Calaveras River has probably been marginal for salmon production due to dry streambeds during summer and fall and lack of suitable habitat for spring-run salmon (Yoshiyama, Gerstung, Fisher and Moyle 1996). Chinook salmon utilized the river on an irregular basis (DFG 1993) probably only during exceptionally wet years. Anecdotal information collected by DWR indicates Chinook salmon migrated as far upstream as the old Hogan Dam in wet springs of the 1930s and 1940s and that salmon held in deep pools downstream of the dam. Winter-run salmon spawned in the river in six different years from 1972 to 1984. The winter-run size varied from 100 to 1,000 fish. They spawned just below New Hogan Dam. It is unknown if this run predated the dams. Operation of the New Hogan Dam may have increased the frequency of the runs into the Calaveras River by creating a more constant flow (DFG 1993).

Today, fall-run salmon occasionally enter the Calaveras River and Mormon Slough if there are adequate flows and low temperatures in fall. Several hundred fall-run salmon were observed during fall 1995 at Bellota Dam (Yoshiyama and others 1996). Steelhead trout have also been reported in the river (Li 1986), however, population estimates are unavailable.

Water Quality

Warm water is a major factor limiting anadromous fish production. Releases from New Hogan Lake directly affect temperatures. Elevated temperatures impact both spawning and rearing as well as fish migration patterns in the river (USFWS 1995). Temperature impacts can be mitigated by establishing a minimum pool size at New Hogan and a release schedule that would allow adequate minimum instream flows (USFWS 1995).

Hydrology

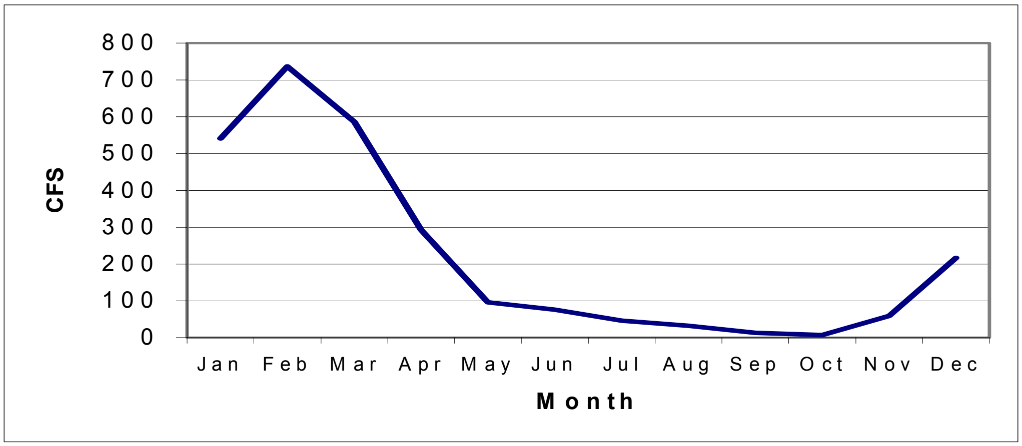

Figure 35 Mean Streamflow at USGS stream gage 11309500 on the Calaveras at Jenny Lind from 1907 to 1966 (USGS 2002).

There are no dedicated fishery flows or minimum instream flow requirements, and insufficient flow limits anadromous fish production in the Calaveras River (DFG 1993; USFWS 1995). Adequate flow is necessary at the confluence with the San Joaquin River to attract fish into the river. Sufficient flow at the Bellota weir is necessary to allow passage over it to the upstream spawning area. Spawning and rearing requires adequate sustained flows. Finally, timing of downstream migration can be delayed due to insufficient flow. Flows in the Calaveras River drop off in September, especially in drought years (USFWS 1995).

Flow data is very limited for the Calaveras River. The U.S. Geological Survey measured flows on the Calaveras River north of Linden from 1944 to 1950 and at Jenny Lind from 1908 to 1966 (USGS 2000). Flows have been measured on the river at the Bellota weir since 1997 (USGS 2000). Flow data farther downstream, beyond the irrigation diversions, is unavailable.

Peak flows during the winter months generally ranged from 1,000 to 5,000 cfs, while flows during the summer and fall were generally minimal to nonexistent (USGS 2000).

Habitat Quality

Most diversions on the Calaveras River are not screened or their screens are inadequate (DFG 1993). The lack of adequate screening causes entrainment losses of salmonid juveniles.

Upstream of Bellota, existing Calaveras River spawning gravels and riparian canopy have been described as adequate. Bank and streambed conditions are considered minor impediments when compared to the major impact of insufficient streamflow. (DFG 1993).

Chinook salmon spawning habitat was surveyed 1.5 miles downstream of New Hogan Dam. Few potentially suitable spawning riffles were found. Conditions indicated relatively poor quality gravel and relatively high levels of sands and fines. Spawning habitat was not thought to be limiting due to the low escapement into the Calaveras River observed in recent years (Vick and Pederson 2000).

Habitat Data

A preliminary instream flow methodology study was prepared by USFWS in 1992. The study provided a range of required flows for winter-run salmon spawning and rearing habitat; however, it was conducted over a limited range of flow conditions (DFG 1993).

A reconnaissance evaluation of spawning gravels within a 1.5-mile reach downstream of New Hogan Dam was conducted in 1999 by USFWS (Vick and Pederson 2000). The evaluation found limited area suitable for Chinook salmon spawning in the reach between the dam and the downstream gorge.

Fisheries and Restoration Projects

Lack of adequate flow has been such a significant constraint to fish production in the Calaveras River that other factors such as habitat quality have not received much scrutiny. Operation of New Hogan Dam and minimum instream flows have become critical issues and, as a result, a more comprehensive view is now being taken of the watershed with various fishery, fish passage, and habitat evaluations either under way or proposed.

USFWS contracted with Stillwater Ecosystem, Watershed and Riverine Sciences to conduct a reconnaissance evaluation of spawning gravels within a 1.5-mile reach downstream of New Hogan Dam. The survey was completed in 1999 (USFWS 2000a). The evaluation found limited area suitable for Chinook salmon spawning in the reach between the dam and the downstream gorge.

Calaveras County Water District and Stockton East Water District have contracted to have a Watershed Management Plan prepared using a $200,000 State Water Resources Control Board grant. (USFWS 2000b). Phase I of the Plan was completed in April 2001. Phase II, Baseline Water Quality Monitoring, will begin in January 2003. Phase II is funded with a $195,000 CALFED grant.

Stockton East Water District and Calaveras County Water District were awarded $670,000 CALFED grant to study the feasibility and develop preliminary designs for screening facilities between New Hogan Dam and Bellota weir.

The Fishery Foundation was awarded a $314,704 CALFED grant to study Chinook salmon and steelhead life history and habitat conditions on the Calaveras River under a cooperative agreement with the Anadromous Fish Restoration Program.

DWR's Fish Passage Improvement Program began a barrier survey and evaluation in July 2001 on the Calaveras River from the confluence with the San Joaquin River to New Hogan Dam, including Mormon Slough and other primary channels.

Merced River, Merced and Mariposa Counties

Potential Impediments to Anadromous Fish Migration

Merced Falls Dam, built in 1901, and New Exchequer Dam, built in 1967, are impassable barriers on the Merced River and limit upstream migration. In addition, four other dams, two roads, and 17 gravel pits are potential impediments to upstream and downstream migration.

General Description

The Merced River is 136.5 miles long and has a watershed that covers 1,273 square miles. It flows into the San Joaquin River at River Mile 118. Most of the water in the Merced River comes from spring snowmelt in the Sierra Nevada and rainfall in the fall and winter.

Fish Populations

Central Valley steelhead, spring-run Chinook salmon, and fall–run Chinook salmon all historically occurred on the Merced River. Unknown numbers of Chinook salmon may have reached the vicinity of Yosemite Valley, although this is not agreed upon (Yoshiyama and others 1996). Salmon most likely entered the South Fork Merced River and traveled to Peach Tree Bar, where a waterfall is a natural barrier. If this barrier was overcome, salmon would have met with another waterfall, considered unsurpassable, 10 miles below Merced Falls (Yoshiyama and others 1996).

Exchequer Dam, built in 1929, permanently barred salmon from traditional spawning grounds upstream. Naturally spawning fall–run fish have been seen in a stretch of river from just above Highway 59 to the Crocker-Huffman Diversion Dam. It is here that the Merced River Hatchery is located and spawners are caught for use as brood stock. By 1929, flows were greatly depleted by water diversion and irrigation, water temperatures became too hot, and fish that made it into the shallow waters of the lower Merced River soon perished (Yoshiyama and others 1996).

Today, fall-run, late-fall run, and some Central Valley steelhead occur in the Merced River (Fry 1960). Annual fall-run Chinook salmon surveys have been conducted since 1940, although data from the first two years was recorded as incomplete (Brown 1996). DFG counted 600 or fewer Chinook salmon each year between 1942 and 1969, except in 1954 when that number increased to 4,000 (Fry 1960; Brown 1996). Due to increased irrigation demands, fewer than 100 fish were documented each year from 1961 to 1966 (Menchen 1980). Fall run numbers have begun to increase since 1970, however, due to increased streamflow released by the Merced Irrigation District and actions of the Merced River Hatchery (Yoshiyama and others 1996).

The enlargement of New Exchequer Dam increased streamflow for salmon, beginning in fall 1967 (Menchen 1980). Between 1967 and 1991, the average returning number of fall-run Chinook salmon was 4,035 fish, with a low of 24 fish in 1990 and a high of 24,660 fish in 1984 (CH2MHill 1998). A few large rainbow trout that appear to be Central Valley steelhead still enter the Merced River Hatchery every year (McEwan and Jackson 1996).

Water Quality

Water quality along the Merced River is poor, due to point and non-point discharge of contaminants such as endosulfan and toxaphene into river sediment (CH2MHill 1998). Organophosphates used on orchards of stone fruit and nuts during the winter, including chlorpyrifos, diazinon, methidathion, and carbaryl, also reach the river via storm runoff (Ross and others 1996). DDT is still detected along parts of the Merced River, according to USGS. In addition, potential mercury contamination of Lake McClure was noted by SWRCB (Brown 1966).

Hydrology

Low flow rates along the Merced River impact all life stages of fish. The result is an increase in temperature, inhibiting spawning and reducing egg and juvenile survival. In the summer, the flow release of 25 cfs is consumed by diversions before it reaches the river mouth. Inadequate flows from the Merced River in October cause fish to stray into agricultural drainage ditches during their upstream migration (Jones and Stokes 1998).

From 1941 until 1966, the median discharge on the Merced River near Stevinson was 200 cfs and the runoff volume was 499,400 acre-feet. Between 1967 and 1995, it was 270 cfs and 493,800 acre-feet, respectively (Mussetter Engineering 2000). The median discharge below Merced Falls Dam was 860 cfs between 1902 and 1966; the runoff volume was 928,600 acre-feet (Mussetter Engineering 2000). After 1968, when the New Exchequer Dam was completed, the annual runoff averaged 939,000 acre-feet downstream of Merced Falls Dam and had an average annual flow of 1,295 cfs. New Exchequer Dam has a maximum objective flood control release of 6,000 cfs (CH2MHill 1999; Mussetter Engineering 2000).

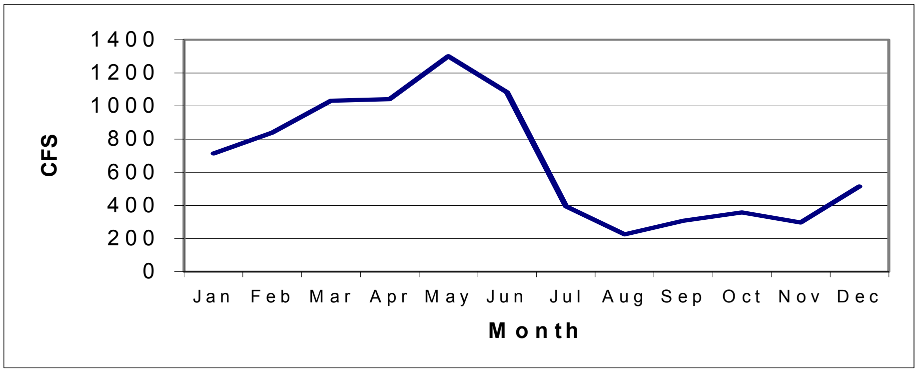

Figure 36. Mean streamflow data from USGS stream gage station 11272500 on the Merced River at Stevinson from 1940-1995 (USGS 2002).

USGS collected streamflow data on the Merced River below Merced Falls Dam from 1902 to 1913 and from 1917 to 1977, and near Stevinson from 1941 to 1995 (USGS 2001). DWR collected flow data near Cressey, Stevinson, and Snelling since 1997, and temperature data near Cressey and Stevinson since 2000 (DWR 2001).

Habitat Quality

Natural vegetation along the Merced River begins as coniferous forest, transitioning gradually with lowering elevation to oak woodland, chaparral, and annual grassland. The physical habitat is more degraded along the Merced River than along any of the other major San Joaquin River tributaries, primarily because of low flows. In addition, much of the streambank vegetation has been removed, causing more erosion (CH2MHill 1998)

Siltation and sedimentation are physical problems associated with mining activity and removal of streambank vegetation along the Merced River. Also, lack of gravel recruitment due to reservoir capture has been identified as a problem contributing to a reduction in spawning (CH2MHill 1998).

Habitat Data

Riparian vegetation along the Merced River was mapped in 1999 by the Sacramento and San Joaquin Rivers Basin Comprehensive Study, a U.S. Army Corps of Engineers program and is available as an ArcView project file.

Fisheries and Restoration Projects

The planting of yearling salmon in the Merced River by DFG began in 1965. Between 1969 and 1972, a salmon spawning channel and two, 250 by 20-foot rearing ponds were constructed in the gravel mining tailings at the base of Crocker-Huffman Dam, and six irrigation diversions were screened (Menchen 1980).

In 1996, the Magneson Isolation Project was completed on a half-mile stretch of the river 2 miles upstream of Cressey. The project isolated an abandoned gravel pit and revegetated the surrounding area. Cooperating agencies included DWR and DFG and funding was provided by the Delta Pumps Fish Protection Agreement (CH2MHill 1998).

The Merced River Salmon Habitat Enhancement Project, funded by DWR, DFG, the CALFED Bay–Delta Program, the Anadromous Fish Restoration Program, and local landowners, will remove predator habitat by filling and eliminating gravel pits. The four-phase project began with the Ratzlaff pit, which was constructed in October 1999. Phase 2, Robinson/Gallo, is in progress. The Robinson/Gallo Project and the Merced River Gravel Replenishment Project were initiated to ensure adequate gravel production previously inhibited by mining and damming. This involves the reconfiguration of the channel and revegetation of streambanks with native vegetation. The revegetation will include the strategic placement of trees to provide stream shade. Phase 3, Lower Western Stone, and the fourth phase, Western Stone, are scheduled for construction in 2003 (DWR 2000).

Projects outlined by the Central Valley Project Improvement Act include the screening of 49 small pump diversions along the river to prevent entrainment of juveniles during migration. Also, increased enforcement of pollution control, poaching regulations, screening requirements, and streambed alterations are recommended during migration. (CH2MHill 1998). Additional actions include purchasing riparian and floodplain lands, reconfiguring channels and river/floodplain relationships, and eliminating routes to in-channel and off–channel predatory pools (CH2MHill 1998).

Finally, the Anadromous Fish Restoration Program proposes to evaluate the use of PHABSIM/D computer modeling of spawning and rearing habitat to assess the benefits of restoration on the Merced River (USFWS 1995).

Stanislaus River, San Joaquin and Stanislaus Counties

Potential Impediments to Anadromous Fish Migration

The construction of dams on the river began in 1858 with Tulloch Dam. The two dams that followed, Goodwin Dam, constructed in 1912 at RM 46.5, and New Melones Dam, completed in 1978 at RM 56.4, both impede spawning in upstream reaches. Goodwin Dam is the upstream limit of migration. The remains of Old Melones Dam, now covered by New Melones Lake, creates a barrier to cold water released from the reservoir into the river. In addition to these three dams there are many potential impediments to migration including 21 gravel and quarry pits and a bridge.

General Description

The Stanislaus River runs southwest from the Sierra Nevada to river mile 75 of the San Joaquin River and is 118.1 miles long. This confluence forms the legal boundary between the San Joaquin River System and the Sacramento - San Joaquin Delta (Brown 1996). The watershed is 1,075 square miles and elevations range from 25 feet at its confluence with the San Joaquin River to 10,000 feet at its headwaters (CH2MHill, 1999).

Fish Populations

Historically, Central Valley steelhead and spring- and fall-runs of Chinook salmon occurred in the Stanislaus River, with the spring-run predominant. Late fall-run and winter-run Chinook populations have not been recorded in the Stanislaus River (Demko 1998). The building of Goodwin Dam in 1912 created an impassable barrier at River Mile 46.5, making habitat on the Stanislaus River suitable only for fall-run due to reduced flows and increased water temperatures (Fry 1960). Chinook salmon were historically found near Duck Bar, which is now covered by the upper end of New Melones Lake. The North Fork of the Stanislaus River is deemed accessible to McKays Point and the Middle Fork to the reach above Beardsley Lake. The South Fork, which contains no salmon, was found historically to have poor habitat (Yoshiyama and others 1996).

Old redd beds were seen in 1939 in the reach between Riverbank Bridge and Malone Power House, 9 miles of which was difficult for salmon to access (Yoshiyama and others 1996). There are spawning beds on the 23-mile stretch of river between Riverbank and Goodwin Dam, concentrated at Two-mile Bar. Rearing occurs along 51 miles of the lower Stanislaus River basin (Yoshiyama and others 1996).

Annual fall-run Chinook salmon surveys have been conducted on the Stanislaus River since 1940. The largest recorded run occurred in 1985 with 40,300 fish (Fry 1960; Brown 1996). The second highest run, occurring in 1953, totaled 35,000 fish. The smallest run was 200 in 1963 (Menchen 1980, Brown 1996). Annual fall-run numbers have averaged 13,000 since 1970. SP Cramer and Associates captured 30,427 Chinook near Oakdale during 115 sampling days between February 1993 and June 1996. It also captured 2,468 Chinook salmon near Caswell Memorial State Park during 143 sampling days in 1995 and 1996. Of these, 2,424 were natural migrants (Demko 1996). Population estimates for all age classes in 1998 were 10,820 (CH2MHill 1998). Between 1992 and 1997 Yoshiyama noted estimated spawning escapement for adult fall-run Chinook was 600 (Yoshiyama and others 2000). Target production numbers for Stanislaus River fall-run under the California Valley Project Improvement Act 1998 plan is 21,640.

Central Valley steelhead are thought to have historically occurred along 113 miles of the Stanislaus River. Following the construction of major dams, this was reduced to about 50 miles (DWR and USBR 1999). A National Marine Fisheries Service (NMFS) genetic analysis of Central Valley steelhead in the river concluded that this population is part of a distinct genetic group made up of populations in Mill Creek, Deer Creek, and the Coleman and Feather River hatcheries (Interagency Ecological Program Steelhead Project Work Team 1999).

A population survey conducted by S. P. Cramer and Associates near Caswell Memorial State Park in 1995 and 1996 resulted in the capture of four Central Valley steelhead (Demko 1996). In 1998, they captured 20 Central Valley steelhead between January and July (Demko 1998).

Water Quality

In 1996, dissolved oxygen and water temperature in the Stanislaus River spawning areas were measured. October intragravel dissolved oxygen concentrations at most of the sites were above the EPA standard of at least 80 percent saturation, although levels in the artificial redds ranged between the lethal level of 50 percent and the EPA standard of 80 percent. The lowest intragravel dissolved oxygen concentrations were adjacent to a grassy field and orchard across from the Army Corps of Engineers Knights Ferry Recreation Area. The highest temperatures were in areas where no spawning was occurring and dissolved oxygen levels were suboptimal or lethal (Mesick 1997).

Mining in Copperopolis has resulted in higher than normal concentrations of copper in Tulloch Reservoir, which feeds into the Stanislaus River (CH2MHill 1998). Copper is acutely lethal to rainbow trout in concentrations of 1 milligrams per liter (mg/L) at 5 degrees centigrade, and 0.5 mg/L at warmer temperatures of 12-18 degrees centigrade. Olfaction, chemosensory perception, and consequently the ability to avoid the chemical, are impaired in Chinook salmon when copper levels reach 50 µg Cu/L (Hansen and others 1999).

High nitrate concentrations were documented in the Stanislaus River in 1995 between Orange Blossom Bridge and Riverbank, suggesting that agriculture and wastewater contaminants are impacting this spawning reach. In 1996, intragravel nitrate concentrations at Honolulu Recreation Area, Orange Blossom Bridge, Valley Oak Recreation Area, and Oakdale Recreation Area were documented at levels between 0.8 and 1.0 mg/L, twice as high as the upstream sampling sites. (Mesick 1997)

Hydrology

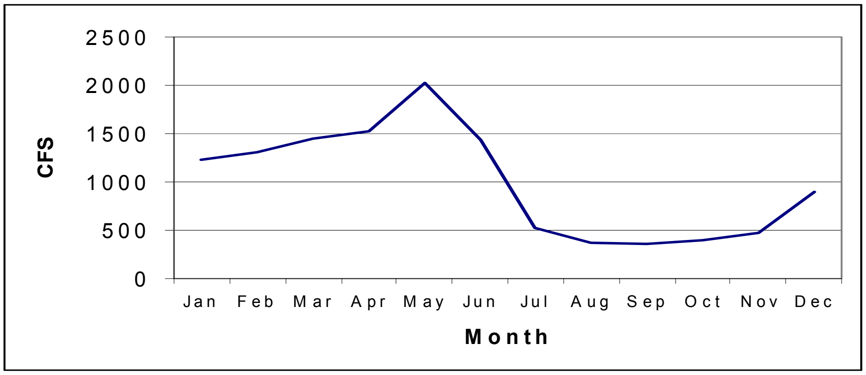

Figure 37. Mean Stream flow of USGS stream gage station 11302500 on the Stanislaus River at Ripon from 1940-2000 (USGS 2002).

Until 1978, the median discharge and runoff volume below Goodwin Dam were 45 cfs and 525,500 acre-feet, respectively. After 1978 and the completion of New Melones Dam, the figures were 360 cfs and 578,700 acre-feet, respectively. The gage near Ripon recorded 310 cfs and 729,000 acre-feet before 1978, then 500 cfs and 701,500 acre-feet. The maximum objective flood control release from New Melones and Tulloch Dams is 8,000 cfs. (Mussetter Engineering 2000)

Stanislaus River flows were extremely low in 1976 (average 142 cfs) and 1977 (average 22 cfs), which prevented spawning in the fall of 1977 (EA Engineering, Science and Technology 1991). Flow rates between 1978 and 1999 averaged 1,500 cfs in March and 600 cfs in July to November (CH2MHill 1999). Between 1994 and1996, Carl Mesick Consultants documented October-November streamflows between Goodwin Dam and Riverbank of 275-300 cfs in 1994 and 1995, and 350-400 cfs in 1996 (Mesick 1997). SP Cramer and Associates also measured streamflow at its trapping locations in 1996. The flow near Oakdale and Caswell Memorial State Parks ranged from 302 cfs on 3 Feb to 3,975 on 5 Mar (Demko 1996).

According to the U.S. Fish and Wildlife Service, an instream flow of 300 cfs between 15 Oct and 31 Dec would maximize Chinook salmon spawning habitat on the Stanislaus River, 150 cfs between 1 Jan and 15 Feb would maximize egg incubation, and 200 cfs between 15 Feb and 15 Oct would maximize juvenile habitat availability (Aceituno 1993).

Streamflow data for the Stanislaus River has been collected by USGS below Goodwin Dam since 1958 and in Ripon since 1941 (USGS 2001). DWR has been collecting temperature data at Jacob Myers Park and Oakdale Recreation Area since 2001 (DWR 2001).

Habitat Quality

Vegetation along the Stanislaus River begins as coniferous forest in the Sierra, then transitions to oak woodland, foothill pine and chaparral. In the basin, the predominant vegetation is grassland. Lack of riparian vegetation for shade has become a problem along the Valley corridor due to agricultural encroachment. Areas where riparian vegetation remains (willow, willow scrub, cottonwoods, valley oak) are largely protected by easements and title holdings of the U.S. Army Corps of Engineers (CH2MHill 1998).

Elevated fall water temperatures may result in delayed spawning and migration, which would delay smolt outmigration and possibly decrease survival rates. Sedimentation caused by grazing, mining, low flows, and streambank modification has also become a problem for spawning and rearing salmonids. Additional problems facing salmonids on the Stanislaus

River include: reduction in overall habitat space, lack of spawning gravel, entrainment at unscreened pumps, and illegal take of adult salmon by poachers. Finally, predation threatens Chinook salmon in the Stanislaus River due to increased predator habitat in abandoned gravel pits (CH2MHill 1998).

Habitat Data

Riparian vegetation along the Stanislaus River was mapped in 1999 by the Sacramento and San Joaquin Rivers Basin Comprehensive Study, a program of the U.S. Army Corps of Engineers and is available from the Corps as an ArcView project file.

Fisheries and Restoration Projects

Current actions proposed under the CVPIA include improving watershed management and restoring instream and riparian habitat. They recommend replacing riparian vegetation impacted by the construction of Highway 108 and Highway 120, and providing shade, cover, food sources, and decreasing sedimentation. Proposed projects to replace and provide maintenance for gravel recruitment would increase quality and quantity of substrates available along the river (USFWS 1995). In addition, proposals exist for screening of diversions to prevent entrainment. A gravel pit isolation project on the Stanislaus River, Willm's Restoration Site (approved in 1996), was stopped due to landowner concerns and no future action is planned (CH2MHill 1998).

In 1999, the Anadromous Fish Restoration Program (AFRP) proposed evaluation of causes and locations of mortality on the Stanislaus River using continuous radio tagging of juvenile Chinook salmon. These studies are being carried out by SP Cramer and Associates and funded by the Oakdale Irrigation District (Demko 1998). Legal action was also proposed to reduce illegal harvest (USFWS 1995).

The Stanislaus River Stakeholders Fishery Task Force is working on a plan to restore the instream and riparian habitats between Goodwin Dam and the confluence with the San Joaquin River. Its goal is to sustain native terrestrial and aquatic species in this area while meeting CVPIA goals. The plan primarily involves controlling streamflow released from Goodwin Dam, with cooperative habitat restoration projects where adjacent landowners and managers are willing (Mesick 1998).

Tuolumne River, Stanislaus and Tuolumne Counties

Potential Impediments to Anadromous Fish Migration

On the South and North Forks of the Tuolumne River, large waterfalls historically limited upstream access. Once Hetch Hetchy Reservoir (O'Shaughnessy Dam) was constructed in 1923, no salmon occurred above this barrier. In 1870, various irrigation projects and dams were constructed, leading to decreased fish passage. Wheaton Dam, built in 1871 at the falls above La Grange, impeded fish passage, but not as much as the La Grange Dam itself when it was built in 1893 (Yoshiyama et al. 1996).

Two dams on the Tuolumne River present impassable barriers, La Grange Dam at RM 54 and New Don Pedro Dam and reservoir at RM 56. In addition to these barriers, other potential impediments to upstream and downstream migration include four other dams, five bridges, and 14 gravel pits.

General Description

Fed by summer snowmelt and seasonal rain, the Tuolumne River is the largest tributary to the San Joaquin River. The Tuolumne River flows southwesterly from its source in the Sierra Nevada Mountains to its confluence with the San Joaquin River at River Mile 83 just west of Modesto. It runs for 141 miles and drains approximately 1,900 square miles (McBain & Trush 1998).

Fish Populations

Both fall and spring–run Chinook salmon historically occurred in the Tuolumne River. The first recorded Chinook salmon sighting on the Tuolumne River came from the Fremont expedition in 1845 (Ogden 1988). Clavey Falls may have partially obstructed migration, but there is evidence to support spring-run passage at this barrier. Central Valley steelhead were noted to have ascended several miles to Cherry Creek and therefore spring-run Chinook salmon may have done so as well. The Tuolumne River has not hosted spring-run Chinook salmon since 1959, due to low flows and high water temperatures in the summer (Fry 1960).

Annual fall-run Chinook salmon surveys have been conducted on the Tuolumne River since 1940 (Brown 1996). The Modesto Dam was condemned in 1947, so there were no further counts at this location, and later numbers are based on DFG estimates. The greatest number of Chinook salmon was 130,000 fish documented in 1944. The number of spawning salmon between 1958 and 1981 ranged from a high of 45,000 in 1953 and 1960 to a low of 100 in 1963. The average number of spawners was 26,000 (Fry 1960; Menchen 1980; DWR 1982; Brown 1996). The maximum production estimated for the Tuolumne River, under current habitat conditions, is an escapement of 15,000 individuals (McBain & Trush 1998). The Federal Energy Regulatory Commission (FERC) made fish surveys a Don Pedro Project monitoring requirement in 1971 (Heyne 2000).

At Dennett Dam near Modesto, the DFG counted 66 Central Valley steelhead in 1940 and six in 1941 (McEwan and Jackson 1996).

Water Quality and Hydrology

Variable streamflow and seasonal flooding in the Tuolumne River is critical to salmonid migration. It serves to maximize available spawning habitat by providing variable depths, removing excess silt, sand and fine debris from gravel, and causing increased spawning on marginal habitat. Regulated baseflow at levels below 100 cfs may limit spawning to center channels and lead to redd superimposition (McBain & Trush 1998).

Seasonal storm runoff carries high levels of insecticides, including Diazinon and Methidathion, from dormant orchards near the Tuolumne River (Ross et al 1996; Kratzer 1998). Daizinon and other pesticides in the Tuolumne River may exceed levels known to be toxic to aquatic life (Dubrovsky 1998). Bioaccumulation of pesticides is suspected at the confluence of the Tuolumne and the San Joaquin Rivers. Organochlorines in biota exceed the National Academy of Sciences and National Academy of Engineering's recommended tissue concentrations for protection of fish–eating wildlife. These chemicals make their way into the river system during winter storms and through urban runoff (Brown 1998). The Tuolumne River is also a source of mercury (Brown 1998).

Prior to 1971, the median discharge was 760 cfs and the runoff volume was 1,052,300 acre-feet. After 1971 and the completion of New Don Pedro Dam, the median discharge was 370 cfs and the runoff volume was 731,800 acre-feet. The maximum objective flood control release from Don Pedro Dam is 9,000 cfs (Mussetter Engineering 2000). Approximately half of the river's runoff is exported to the cities of Turlock, Modesto, and San Francisco, who have appropriative water rights (DWR 1982; CH2MHill 1998). Individuals with riparian water rights divert approximately 19,400 acre-feet per year (DWR 1982).

Habitat Quality

Alluvial portions of the Tuolumne River are the areas of greatest biodiversity, containing sandbars that create topographical diversity and provide habitat for all life stages of Chinook salmon. In 1986, EA Engineering, Science, and Technology (EA) documented 2.9 million square feet of riffle area below La Grange Dam, when streamflow was maintained at 230 cfs. This provided up to 13,500 spawning sites, assuming that all riffles were spawnable (EA Engineering 1993). Increased flows would progressively expose more suitable spawning ground on adjacent bars and stream margins (McBain and Trush 1998). Eleven riffles found between RM 35.5 and 40.2 had especially good and well used spawning gravel. The best and most undisturbed of these was located at RM 38 (McBain and Trush 1998).

Currently, encroaching vegetation has narrowed and reduced total spawning area in these riffles by 43%. Floods in 1997 also impacted spawning gravel, causing scours and creating deep runs and steep riffles in reaches where bridges, dikes, and agricultural encroachment existed. Riffles 1A, 1C, 6, 9B, and 11, all downstream of Old Basso Bridge at RM 48, were some of those most directly affected (McBain and Trush 1998).

Superimposition was found to be a major factor in mortality rates from RM 50.5 (Old La Grange Bridge) to RM 47.6. An estimated 53% of all spawners on the Tuolumne River used this site, yet only one fifth of total available spawning gravel is found in this location (EA Engineering 1991; McBain and Trush 1998).

Gravel quality on the river has grossly diminished due to decreased scouring and channel forming flows, increased sediment from Gasburg Creek, and elimination of coarse bedload from sources above La Grange Dam. Gravel quality assessments conducted in 1987 and 1988 found that the overall survival of redds (incorporating baseline survival, red survival, emergence and length fecundity data) was 34% (McBain and Trush 1998).

Riparian vegetation removal and in–channel gravel mining has increased siltation and decreased water quality. Downstream of La Grange Dam, low flows that impede spawning and out migration have been documented in the fall and temperatures as high as 30 °C have been recorded in the summer. Lethal temperatures for Chinook salmon range from 25.0-28.8 °C. Flow fluctuations from hydroelectric facilities occur between December and February, disrupting adult fish passage, causing juvenile stranding and redd dewatering, and impacting water quality. The presence of pesticides and herbicides, although not consistently documented, may also decrease salmon survival (CH2MHill 1998).

The primary predators on the Tuolumne River are largemouth and smallmouth bass. Studies conducted by the DFG estimate that these fish are responsible for up to 69% of the total mortality of 90,000 smolts during their 3-day migration. Predators were found to be more abundant in Section 1 (RM 25-52) than in Section 2 (RM 0 –25), with the highest concentration being found in special–run pools left from in-channel aggregate mining. Largemouth bass have an estimated May population of 11,000 bass within a 52 mile reach of the Tuolumne River. Illegal harvest of adult Chinook salmon is another concern. (USFWS 1995).

Habitat Data

Streamflow data has been collected near La Grange Dam from 1912-1997 and in Modesto in 1896 and from 1940-1997 (USGS 2001). DWR has been collecting streamflow data at these two locations since 1997 (DWR 2001).

Riparian vegetation along the Tuolumne River was mapped in 1999 by the Sacramento and San Joaquin Rivers Basin Comprehensive Study, a program of the U.S. Army Corps of Engineers, and is available from the Corps as an ArcView project file.

Fish Passage and Restoration Projects

CVPIA restoration and improvement action plans for the Tuolumne River are funded by the Tuolumne River Technial Advisory Committee and the AFRP. These plans include gravel restoration and augmentation as well as habitat protection. Large in-channel and off-channel pool connections would be physically eliminated to decrease predation by large warm water fishes. Legal action is recommended to reduce poaching, pollution, and streambed alteration. Twenty small, unscreened pumps are proposed for screening to protect juveniles.

Actions are already underway to decrease sedimentation under the supervision of the M.J. Ruddy Erosion Control Project Phase II. This project, along with the Basso Bridge Area Project and the Basso Bridge Land Acquisition Project, will clean spawning areas and secure lands with good riparian habitat for salmonids (CH2MHill 1998).

The New Don Pedro Project and Article 39 of the Federal Energy Regulatory Commission (FERC) 1964 license agreement with Turlock Irrigation District and Modesto Irrigation District called for a 20 year fishery evaluation on the river. The evaluation is still ongoing, due to past drought conditions. This is a cooperative study involving Tulare and Modesto irrigation districts, DFG, and the U.S. Fish and Wildlife Service (McBain and Trush 1998).

In 1986, DFG and the districts developed a new flow management regime to incorporate the needs of Chinook salmon and Central Valley steelhead. This flow schedule has not yet been approved by FERC. The USFWS and the City and County of San Francisco have filed their own recommendations with FERC. FERC currently requires the release of a fall attraction pulse flow, with magnitudes up to 2,500 cfs for 3 days to reduce natural storm variability and maintain water flow variability during the 45 day spawning period (McBain and Trush 1998).

Several gravel pit elimination and channel modification projects have been funded and carried out by the Turlock Irrigation District including: the $6.7 million Mining Reach Project located between Waterford and Robers Ferry Road and constructed in 2000; the $6,455,000 reconstruction of the Ruddy Restoration Project and elimination of other pits situated within the Mining Reach Project is planned in 2002/2003; and the $4,760,000 Special Run Pools 9 and 10 Project is expected to begin in 2001. In addition, the $277,000 Reed Restoration Site Plan was approved for funding by the Delta Pumps Fish Protection Agreement

(4-Pumps), but was halted in 1991 by landowner concerns. In addition, Turlock Irrigation District will construct an infiltration gallery downstream of La Grange Dam in order to increase flows in the 26-mile stretch of river downstream of the dam and improve salmonoid spawning and rearing habitat during irrigation season. Construction could begin in 2001.

A project was also proposed by AFRP to evaluate the use of PHABSIB/D modeling of spawning and rearing habitat to assess benefits of restoration on the Tuolumne River (USFWS 1995).

Bay Area and Delta

Alameda Creek and tributaries, Alameda and Santa Clara Counties

Potential Impediments to Anadromous Fish Migration

The BART Weir and an inflatable dam block fish passage at River Mile 9.7. This is a small portion of the range historically available to anadromous fish (Gunther and others 2000). There are eight dams, three weirs, a road crossing, and a gas pipeline crossing identified in Alameda Creek.

General Description

The Alameda Creek watershed is the largest drainage in the South Bay of the San Francisco Bay Area. It flows from the Diablo Range west through Sunol Valley and Niles Canyon into southeastern San Francisco Bay just north of the Highway 92 bridge. It drains about 700 square miles (Aceituno and others date unknown). Alameda County Water District, San Francisco Public Utilities Commission, and Zone 7 of the Alameda County Flood Control and Water Conservation District use Alameda Creek and its tributaries for water supply and transport. The lower 11 miles of the creek have been channelized for flood control (Gunther and others 2000). In addition to Alameda Creek, two large and several small tributaries are described below.

Fish Populations

Alameda Creek is historically home to runs of Coho and Chinook salmon, as well as Central California Coastal steelhead (Alameda Creek Alliance 23 Aug 2000). Today, only steelhead and Chinook salmon ascend the creek. They have recently been observed as far as 8 miles upstream from San Francisco Bay. In July 1995, the California Department of Fish and Game (DFG) did a stream inventory from Calaveras Dam to the Sunol Water Treatment Plant (SWTP). The report identified rainbow trout (DFG 1996). Fifteen rainbows were caught just upstream of Calaveras Creek during a 1987 DFG fish survey (DFG 1988). Follett (Aceituno and others date unknown) also documented rainbow trout in Alameda Creek in 1927, 1955, and 1957.

In 1999, three steelhead were captured at the BART Weir. The Alameda Creek Alliance has videotape and film of them. In recent years, a few Chinook salmon were seen in the flood control channel below the BART Weir. Salmon were also found in archaeological sites in the lower floodplain of Alameda Creek, but it is unknown if those fish were native or if they were transported to the sites (Gunther and others 2000). Run sizes for the salmon and steelhead runs in Alameda Creek are unknown. DFG manages a put-and-take fishery in Alameda Creek by stocking rainbow trout in the Niles Canyon area (Gunther and others 2000).

Water Quality

Alameda Creek is perennial in its upper reaches but is periodically dry in Sunol Valley. Many of the creek's tributaries may be cut off from the mainstem in the summer due to lack of flow. There are three major reservoirs in the Alameda Creek watershed, and water supply practices have greatly altered the natural flow in both the mainstem and its tributaries. The creek is used as a conduit for water by three Bay Area water supply agencies and water from Hetch Hetchy and the South Bay Aqueduct also augment its flows.

Very little water quality information is available. However, water quality does not appear to be a factor to the anadromous fish populations in Alameda Creek. The Niles Canyon area of the creek does have a relatively high summer temperature, "frequently exceeding 22° C and occasionally reaching 26-28° C in the upper part of the reach" (Gunther and others 2000). Water from the Central Valley flows through this watershed due to releases from the South

Bay Aqueduct. This may confuse returning fish and cause straying, but the extent of this straying has not been determined (Gunther and others 2000).

Hydrology

The lower 12 miles of Alameda Creek may become dry during the summer so flow may be a fish passage issue. The average yearly rainfall for Alameda Creek is about 15 inches (Alameda Creek Alliance 2000). Diversions at the Alameda County Diversion Dam may divert as much as 85 percent of the flow out of the creek (Gunther and others 2000). In 1957, a CDF survey found flow to range from 6 cfs to none in May. A 1996 DFG stream inventory reported flows of 3 cfs at the SWTP and 1.5 cfs just upstream of Calaveras Creek. In the same report, temperatures of 64-75° F were recorded for the same reach.

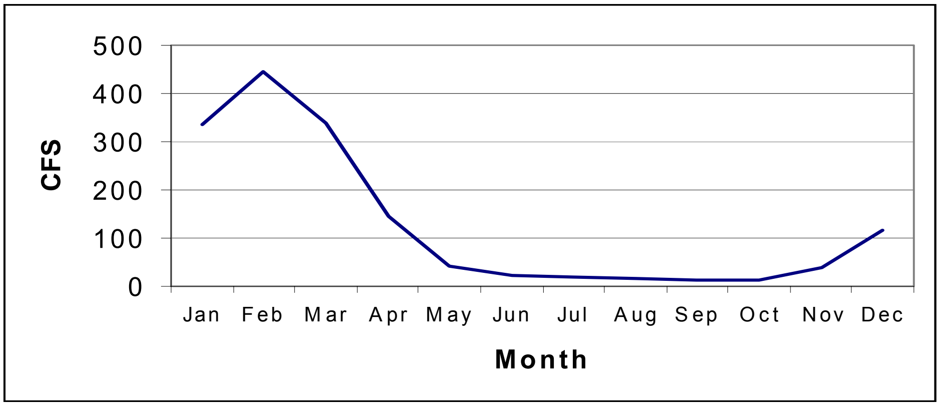

Figure 38. Mean streamflow for USGS stream gage 11179000 on Alameda Creek at Niles from 1891-2000 (USGS 2002).

There are eight USGS gaging stations on Alameda Creek and its tributaries; flow data from 1891 is available from the oldest gaging station. The other stations have data starting from 1912, 1957, 1964, 1994, and 1995 (USGS 2000a-h).

Habitat Quality

The 12-mile section of the creek that runs from San Francisco Bay to the mouth of Niles Canyon is a straight flood control channel. It has a paved bike path on the south side and a gravel equestrian road on the north side. The banks are lined with riprap and there is little vegetation (Horil 2001). Some spawning has been observed downstream of the BART Weir in this section, but the hatching success is estimated to be low due to gravel siltation, frequent flow fluctuation, and loss of channel features, such as pools, riffles, and riparian bank vegetation, as a result of the extensive channelization of the creek bed for flood control. Rearing could not occur in most of this reach. However, this reach may be important habitat for transition between freshwater and ocean habitat because it is tidally influenced (Gunther and others 2000).

The Niles Canyon reach of the river may have supported rainbow trout in the past. Today, the lower section may provide suitable habitat, but high temperatures decrease its value. Increased flow, due to releases from quarry operations in Niles Canyon, may help offset the effects of the increased temperature. Flow here is also augmented by releases for municipal water supply operations. Trout were observed in tributaries of this reach in 1999 (Gunther and others 2000).

The Sunol Valley reach of Alameda Creek has a wide, braided channel, which results in shallow flow and presents passage issues at low flows. There is good spawning substrate in this reach. However, rearing would be prevented by low summer flows and high temperatures caused by a lack of riparian cover. This reach could support trout if the summer temperatures could be lowered (Gunther and others 2000).

The Lower Ohlone reach of Alameda Creek supports a self-sustaining population of rainbow trout, which would indicate good habitat. The stream dries in spots during the summer, but pools provide adequate habitat (Gunther and others 2000). The Upper Ohlone reach has relatively pristine hydrology and supports a population of rainbow trout. This reach dries in the summer above the confluence with Valpe Creek (Gunther and others 2000).

Habitat Data

Habitat data for most of the Alameda Creek watershed is available in an assessment of the creek done for the Alameda Creek Fisheries Workgroup (Gunther and others 2000). Older habitat data is available for small portions of the creek. A 1988 DFG fish sampling report includes habitat data for the area immediately upstream of the Calaveras River and for a reach near the Wooden Bridge Creek crossing (DFG 1988). Temperature, pH, and dissolved oxygen measurements were collected in 1973 at six points in Alameda Creek (Aceituno and others date unknown). A May 1957 DFG stream survey contains channel, temperature, and flow data. A 1996 DFG stream inventory of the creek contains temperature, flow, and channel information as well as gravel location and embeddedness. Anecdotal habitat information is available (Spliethoff 2000, Alameda Creek Alliance 2000)

Fisheries and Restoration Projects

The Alameda Creek Steelhead Restoration Proposal, sponsored by the Alameda Creek Fisheries Restoration Workgroup, recommends removing barriers to anadromous fish migration in the Alameda Creek watershed. The workgroup published a report of habitat conditions and barrier information. The East Bay Regional Parks District has agreed to remove two concrete swim dams at an estimated cost of $100,000. The San Francisco Public Utilities Commission has announced it will study the removal or modification of two dams in the Niles Canyon reach of Alameda Creek. And the Alameda County Flood Control District and Alameda County Water District have teamed up to apply for funds from U.S. Army Corps of Engineers Section 1135 program, Projects for Improvement of the Environment. The money will be used to modify the lower flood control channel dams for fish passage.

In recent years, there have been various rescue efforts to transport steelhead around barriers, to collect fertilized eggs, rear the young, and release them in the Sunol Park area (Gunther and others 2000).

Tributaries

Arroyo Valle

Potential Impediments to Anadromous Fish Migration

Lake Del Valle is the only reservoir on Arroyo Valle and Del Valle Dam is a complete barrier to anadromous fish passage. There is also a drop structure in the creek, but it is not considered to be a passage problem.

General Description

Arroyo Valle begins on the west slopes of Black Mountain near the Santa Clara / Stanislaus County line and runs 33 miles northwest to its confluence with Arroyo de la Laguna at River Mile 6. Arroyo de la Laguna is a tributary to Alameda Creek at River Mile 17.

Fish Populations

In 1962, “steelhead/rainbow” trout were found by Skinner (cited in Gunther and others 2000) in Arroyo Valle. Today there are self-sustaining populations of rainbow trout in tributaries to Lake Del Valle (Gunther and others 2000). In a 1957 stream survey done by DFG before Del Valle Dam was built, rainbow trout were sighted in the upper reaches of the creek. DFG personnel conducting the survey assessed these trout to be resident, not anadromous, trout (DFG 1957). Before the dam was built there is no evidence of rainbow trout being stocked in Arroyo Valle, but steelhead rescued from Uvas Creek were planted in Arroyo Valle (DFG 1957).

The East Bay Regional Parks District and DFG operate a put-and-take rainbow trout fishery in Lake Del Valle, which is owned and operated by DWR. In 1973, DFG planted 45,672 rainbow trout followed by an additional 59,944 trout in 1994 (DFG 1974 and 1975). In 1990, EBRPD planted 54,144 pounds of rainbow trout and DFG planted 28,700 pounds. (DFG 1991). These fish are "planted from September to April or May" (DFG 1991). Sampling of fish in Lake Del Valle by DFG in 1972, 1973, 1976, and 1977 recovered stocked rainbow trout. Rainbow trout are also stocked at Shadow Cliffs Regional Recreation Area (Gunther and others 2000).

Water Quality

Water temperatures in the creek below Lake Del Valle are high. Flow in the lower 11 miles of the creek is heavily influenced by releases from the reservoir. Because it is managed for groundwater recharge, flows in the lower reach are probably erratic (Gunther and others 2000). In 1972, Zone 7 of the Alameda County Flood Control and Water Conservation District agreed to release 10 cfs of water from Del Valle Dam between 24 Apr and 30 Jun. This was arranged so that DFG could stock this area with fish (Zone 7 1972).

Temperature and dissolved oxygen (dissolved oxygen) are also problems in Arroyo Valle. In 1973, DFG measured dissolved oxygen and water temperature in Lake Del Valle near the dam. dissolved oxygen ranged from 5.2 to 10.7 and temperature ranged from 65° F at the surface to 51° F at a depth of 44 feet. DFG fish population surveys between 1972 and 1977 contain minimal temperature data. During a May 1986 survey of the creek below Lake Del Valle, a temperature of 72° F was recorded (Gray 1986).

Hydrology

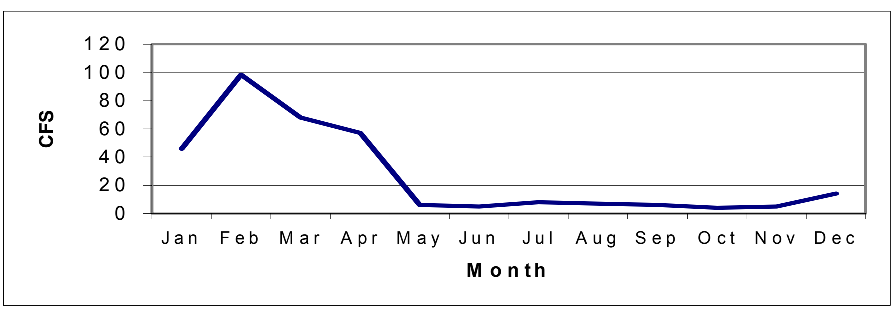

Figure 39. Mean streamflow for stream gage station 1117660 on Arroyo Valle in Pleasanton from 1957-1985 (USGS 2002).

Arroyo Valle is generally dry during the summer. A DFG survey done in mid-May 1957 reported no flow downstream of Pleasanton. Flow data from 1957 to 1999 is available from a USGS gage on Arroyo Valle near Livermore (USGS 2000).

Habitat Quality

Only the lowermost portion of Arroyo Valle has suitable spawning gravel. The portion of the creek below Lake Del Valle is channelized. Water temperatures in the lower reach of the creek are high because there is no shade. There are also high levels of sediment. The portion of this creek accessible to anadromous fish does not offer good spawning or rearing habitat (Gunther and others 2000). A 1957 DFG stream survey of Arroyo Valle described the lower portion of the creek as of little value for fish life while the extreme headwaters were said to "provide fine habitat for trout." In a 1986 DFG survey of the area 2,000 feet below Del Valle Dam the habitat was found to be "very good." It was described as having "a large amount of undercut banks, roots and boulders as well as good clean gravel." Sycamores, alders, and cottonwoods provided an estimated 30 percent canopy cover in this reach (Gray 1986).

Habitat Data

Most of the available habitat data is from habitat surveys done in 1999 in conjunction with An Assessment of the Potential for Restoring a Viable Steelhead Trout Population in the Alameda Creek Watershed, a report published by the Alameda Creek Fisheries Restoration Workgroup. The report also cites a 1962 survey (Gunther and others 2000). According to the assessment, Arroyo Valle is a channelized urban stream from its mouth to Shadow Cliffs Regional Recreation Area, and it is predominantly bordered by riprap. In 1986, DFG conducted a survey of the creek 2,000 feet below Del Valle Dam. Some habitat data was collected during the survey (Gray 1986).

Fisheries and Restoration Projects

During the 1986-1987 drawdown, in which the lake level was lowered, EBRPD, DFG, DWR, and area sport fishing clubs conducted fish habitat work at Lake Del Valle. They planted 250 arroyo willow trees in the southern portion of the reservoir where the banks were devoid of cover. They also anchored brush in the reservoir to provide cover for fish. About 600-800 hardwood limbs were anchored as well. Local Boy Scout troops also helped by collecting 200-300 Christmas trees and anchoring them in the reservoir so they would be in slow, shallow water during high water. They were placed in such a way that they would be easy to replace once decomposed (EBRPD 1987).

Arroyo Mocho

Potential Impediments to Anadromous Fish Migration

There are two drop structures and one road crossing on Arroyo Mocho.

General Description

Arroyo Mocho is part of the Alameda Creek watershed. It is 10 miles long and drains into Arroyo de la Laguna at River Mile 7. Arroyo de la Laguna is a tributary to Alameda Creek at River Mile 6. Arroyo Mocho runs through the Livermore and Amador Valleys.

Fish Populations

"Steelhead/rainbow" trout were documented in Arroyo Mocho in 1962 and today there are self-sustaining populations in the creek (Gunther and others 2000). A 1976 DFG survey found rainbow trout at three places on the creek: Lawrence Livermore pumping station, Cedar Brook Ranch, and Mines Road. A total of 44 rainbow trout were caught at the three sites on 3 Feb. (DFG 1976). In 1978, DFG approved a request to stock trout in a one-mile reach of the creek that runs through Robertson Park in Livermore. Zone 7 of the Alameda County Flood Control and Water Conservation District has allocated water from the South Bay Aqueduct for Arroyo Mocho in adequate amounts to sustain the stocked trout (DFG 1978). There are no estimates of the size of the fish run in Arroyo Mocho.

Water Quality/Hydrology

Flow and temperature are the biggest water quality issues in Arroyo Mocho. Quarries and groundwater recharge have altered the natural flow in the creek. During the summer, this tributary to Alameda Creek is one of the driest and most arid. Arroyo Mocho becomes two distinct sections separated by about 200 yards of creek bed in a gravel quarry area in Pleasanton. That section remains dry for most of the summer. Below this dry reach, water is supplied to Arroyo Mocho by releases from Lawrence Livermore National Laboratories and discharges from quarries (Gunther and others 2000). In the flood control channel reach above the dry area, water supplied by DWR via the South Bay Aqueduct is released into the creek for groundwater recharge. (Gunther and others 2000). Summer flows in the upper reaches of the creek are almost entirely due to water purchased from the State Water Project. Because this water is managed for groundwater recharge, it rarely continues downstream. Water infiltration rates are high in the Livermore Valley, so any excess SWP water is absorbed through the channel bottom and does not flow continuously downstream (Gunther and others 2000).

Zone 7 of the Alameda County Flood Control and Water Conservation District operates three gaging stations in the Arroyo Mocho watershed. Data from these gages, combined with an estimate for quarry pond releases, has been used to estimate flow and determine its adequacy for fish migration. The data suggest there is a range of 20 to 40 cfs in the Pleasanton reach of the flood control channel from January through March and flows are minimal in April and May. During a field survey in October 1999, flows in the upper and lower flood control channel were 10 to 12 cfs. This level of flow appeared to be sufficient for fish migration. Further analysis of the available data led Gunther to the conclusion that there is "a continuous wetted channel adequate for fish migration" through January and March and around storm events (Gunther and others 2000). The quality of water when it is present does not appear to be a limiting factor to anadromous fish populations in Arroyo Mocho (Gunther and others 2000).

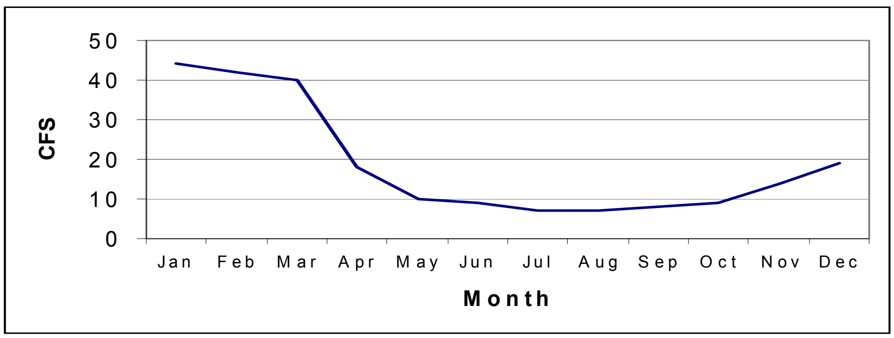

Figure 42. Mean streamflow at stream gage station 11176200 on Arroyo Mocho at Pleasanton from 1962-1985 (USGS 2002).

Habitat Quality

Below Wente Road, the creek channel is channelized and riprapped but it does have a natural bottom. The lower portion is not considered to be suitable spawning or rearing habitat due to lack of shade and high sedimentation. Between Murrieta's Well and the South Bay Aqueduct there is a section of natural channel with varying shade. The water temperature here was 70.5 °F according to a 2000 stream survey and there is predominately a gravel and cobble substrate (Gunther and others. 2000). From the aqueduct to the Mines Road Bridge, flow is low and there is generally less than 25 percent shade. However, temperatures were 20°C in this reach during a 2000 stream survey and trout have been documented here (Gunther and others. 2000). Boulders become more common upstream of this section. Near the Alameda-Santa Clara County line, the creek becomes largely dry with sections shaded mostly by small willows (Gunther and others 2000).

Habitat Data

Most of the habitat information available is from stream surveys done for a report, An Assessment of the Potential for Restoring a Viable Steelhead Trout Population in the Alameda Creek Watershed, published in February 2000 by the Alameda Creek Fisheries Restoration Workgroup. There is also 1964 to 1999 flow data available from the USGS gaging station on Arroyo Mocho near Livermore (USGS 2000).

Fisheries and Restoration Projects

No restoration or fishery projects are being carried out at this time.

Calaveras Creek

Potential Impediments to Anadromous Fish Migration

Calaveras Dam is the only barrier on Calaveras Creek and it is impassable.

General Description

Calaveras Creek is a tributary to Upper Alameda Creek at River Mile 26. It is 5.4 miles long and has one major reservoir, Calaveras Reservoir. The reservoir is fed by natural streams as well as by a pipeline, which delivers Alameda Creek water from a diversion at the Alameda Creek Diversion Dam on Alameda Creek (Gunther and others 2000).

Fish Populations

Calaveras Creek is a tributary to Alameda Creek above several impediments to fish migration. At least one of these barriers is considered to be impassable. This eliminates any anadromous fish from gaining access to Calaveras Creek. There are self-sustaining populations of rainbow trout above Calaveras Reservoir, in an upstream tributary Arroyo Hondo, and possibly in Smith and Isabel Creeks. These populations are probably derived from coastal steelhead, which were trapped in the upper watershed (Gunther and others 2000). According to the Alameda Creek Fisheries Restoration Workgroup report, there were fish surveys of various reaches of Calaveras Creek done in 1905, 1938, 1972, and 1977 (Gunther and others 2000). DFG sampling of Calaveras Reservoir in May, June, August, and October 1973 document a rainbow trout population in the reservoir.

Water Quality

Summer water temperature is relatively high in this creek below Calaveras Dam (Gunther and others 2000). A 1965 limnological study of Calaveras Reservoir contains data about temperature, turbidity, dissolved oxygen, and pH of the water at four sites in the reservoir. Temperatures ranged from 75.5° F to 47.7° F and stratification did occur. dissolved oxygen ranged from 1.6 to 9.0 ppm and pH was 7.5 to 8.5 (DFG 1965). In 1973, DFG recorded water temperature during three fish samplings in the reservoir. The results were 72° F in late May, 76° F in mid June, and 62° F in October.

Hydrology

During a 15 Apr 1988 fish sampling by DFG, flow in Calaveras Creek was measured at 0.068 cfs. The same point measured in September of the same year had a flow of 0.594 cfs. In April flow was not continuous from Calaveras Dam to the confluence with Alameda Creek. Flow was intermittent upstream of the Hetch Hetchy pipe abutment. While USGS does not have a flow gage on Calaveras Creek, there is one on Alameda Creek below its confluence with Calaveras Creek with data available from 1995 to 1999 (USGS 2000).

Habitat Quality

A 1995 stream survey by DFG found that the area between Calaveras Dam and the confluence with Alameda Creek has a very steep gradient with the substrate being mostly very large boulders. It is believed that passage through this section is difficult or impossible at most flows and is therefore considered "unsuitable for the re-establishment of a trout population" (DFG 1996).

Habitat Data

Other than limnological data, very little habitat data is available for Calaveras Creek. No vegetation data was found. A brief mention of channel gradient and substrate can be found in An Assessment of the Potential for Restoring a Viable Steelhead Trout Population in the Alameda Creek Watershed (Gunther and others 2000).

Fish Passage and Restoration Projects

No restoration or fishery projects are being carried out at this time.

Arroyo de la Laguna

Arroyo de la Laguna is a tributary to Alameda Creek parallel to Interstate 680. There are no identified barriers on this tributary and flow appears to be adequate for migration to other tributaries. Below its confluence with Arroyo Mocho, Arroyo de la Laguna has poor breeding and rearing habitat. The substrate is mostly sand, there is poor pool development, and summer temperatures may be high. Sections of Arroyo de la Laguna near Arroyo Mocho have been channelized for flood control. A 1963 survey found rainbow trout in Arroyo de la Laguna; however, DFG fish surveys in 1976 and 1986 did not recover rainbow trout (DFG 1986). Only warm water, nongame fish were caught in these surveys. Some temperature and flow data is available in these fish surveys for limited portions of the creek. The lowermost portion of the creek may be suitable for trout and there is little information about the upper reaches (Gunther and others 2000).

Pirate Creek

Pirate Creek is a tributary to Alameda Creek in the Sunol Valley. Rainbow trout were observed in the lower reaches of Pirate Creek during sampling by Alameda County in 1999 (Gunther and others 2000).

San Antonio Creek

San Antonio Creek is a tributary to Alameda Creek just upstream of the Interstate 680 crossing. Historically there were steelhead in San Antonio Creek but “by the early 1960s, Alameda Creek steelhead runs were essentially eradicated” (DFG 1978). James H.Turner Dam creates San Antonio Reservoir and blocks access to San Antonio, La Costa, and Indian Creek watersheds all of which had steelhead historically (Leidy 1984). There are self-sustaining populations of rainbow trout in tributaries to the reservoir and habitat above the reservoir is considered potential steelhead habitat (Gunther and others. 2000). A 1978 trout survey by DFG reported dense populations of young-of-year rainbow trout in San Antonio Creek above the reservoir, in lower and upper La Costa Creek, and in lower and middle Indian Creek.

Stoneybrook Creek

Stoneybrook Creek is a tributary to Alameda Creek at Palomares Road. DFG found rainbow trout in Stoneybrook Creek in 1976. Rainbow trout have also been documented recently in the creek during sampling by the East Bay Regional Park District. Temperatures in Stoneybrook Creek were consistently measured below 64.4 F (18° C) in summer 1999, which is within the suitable range for steelhead trout (Gunther and others 2000).

Valpe Creek

Valpe Creek is a tributary to upper Alameda Creek. Rainbow trout were seen in Valpe Creek in 1999 (Gunther and others. 2000).

Welsh Creek

Welsh Creek is a tributary to Alameda Creek in Sunol Valley. Alameda County found rainbow trout in the creek during sampling in 1999. There is a natural barrier 0.3 miles from the confluence with Alameda Creek which blocks access to the rest of the creek (Gunther and others 2000).

Sinbad Creek

Sinbad Creek is a tributary to Arroyo de la Laguna near its confluence with Alameda Creek. This creek historically had steelhead in it but does not have a persistent population of rainbow trout. Temperatures in Sinbad Creek were consistently measured at below 64.4°F in summer 1999 (Gunther and others 2000).

San Francisquito Creek, Santa Clara and San Mateo Counties

Potential Impediments to Anadromous Fish Migration

San Francisquito Creek has two dams, a drop structure, a weir and a golf cart crossing that can impede anadromous fish migration between Searsville Dam and its discharge into San Francisco Bay. Searsville Dam blocks the migration of steelhead trout to the tributaries upstream of Searsville Lake.

General Description

The San Francisquito Creek watershed extends 45 square miles from the Santa Cruz Mountains to San Francisco Bay. Several creeks draining Skyline Ridge join together above and below Searsville Lake in Portola Valley to form San Francisquito Creek. Tributaries flowing into San Francisquito Creek above Searsville Lake include Corte Madera Creek, Sausel Creek, Martin Creek, and Alambique Creek. Tributaries flowing into San Francisquito Creek below Searsville Lake include Bear Creek and Los Trancos Creek. The creek continues through the hills above Stanford University, then between Palo Alto and Menlo Park and finally flows into San Francisco Bay.

Fish Populations

Historically, in addition to steelhead trout, San Francisquito Creek supported a run of Chinook salmon (SFEP 1997). There are no records of Central California Coho salmon in the San Francisquito watershed; however, since they are widely distributed, it is possible that they may have inhabited the watershed (Launer and Spain 1998). Today, steelhead trout are the only salmonids inhabiting the San Francisquito watershed. Steelhead trout are found in various tributaries of the Bear Creek watershed (Smith and Harden Date Unknown) and Los Trancos Creek (Launer and Spain 1998). Fish surveys have been performed by the state Department of Fish and Game from 1974 to1996. These fish surveys are unavailable.

Water Quality

The water in San Francisquito Creek has a high silt load and high levels of the pesticide diazinon (USEPA 1998), a widely used organophosphate. As the creek passes through urban Palo Alto and Menlo Park, the creek receives storm water discharges, which can contain various levels of pesticides, oils, heavy metals and other contaminants. Coordinated Resource Management and Planning and the city of Palo Alto sampled and analyzed water for various pesticides and heavy metals in the San Francisquito watershed from 1997 to 1998 (San Francisquito Creek CRMP 13 Sep 2000).

Hydrology

The flows in San Francisquito Creek are highly seasonal. The U.S. Geological Survey (USGS) maintains a stream flow gage at Stanford University and records are available from 1930 to 1941 and since 1950. Historic flows range from peaks of over 1,500 cfs in the winter to less than 0.5 cfs during summer and early fall (USGS 2000). The creek reportedly runs dry in the summer (Cities of Menlo Park, Palo Alto, East Palo Alto, San Mateo County and the Santa Clara County Water District 2000). One USGS gaging station at Stanford University has data available from 1930 to 1941 and since 1950 (USGS Nov. 28, 2000)

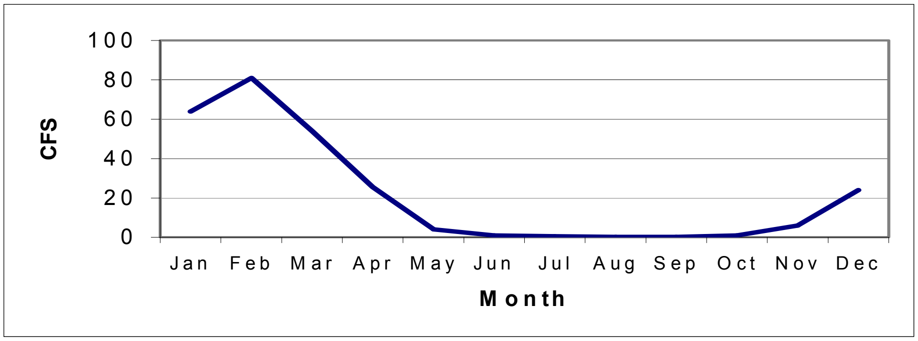

Figure 41. Mean stream flow for USGS stream gage station 11164500 on San Francisquito Creek at Stanford University from 1930-2000 (USGS 2002).

Habitat Quality

The spawning habitat quality of San Francisquito Creek is variable as it flows from the minimally developed lands of Stanford University through the downstream urban areas of Palo Alto and Menlo Park. The reach of San Francisquito Creek between Junipero Serra Boulevard to Highway 101 has been described as suboptimal spawning habitat as most of this area is dominated by fine materials such as sand and by gravel/cobble in the upstream area. This area appears to provide primarily migration habitat for steelhead, although several barriers to migration exist (Cities of Menlo Park, Palo Alto, East Palo Alto, San Mateo County and the Santa Clara County Water District 2000).

The existing shading, summer water temperatures, and spawning habitat have been described as good in the Bear Creek watershed, which is upstream of Searsville Dam. Upper portions of the watershed are protected in parks or California Water Service lands. Streambeds have been described as clean; however, streamflows were low to extremely low in the summer (Smith and Harden, No Date).

The upper San Francisquito watershed has been the focus of fish surveys conducted during the 1990s. Bear Creek and Los Trancos Creek contained the largest number of steelhead and seemed to provide the most significant spawning grounds for the species (Cities of Menlo Park, Palo Alto, East Palo Alto, San Mateo County and the Santa Clara County Water District 2000).

Habitat Data

Studies include Stanford University's surveys in 1997, 1998, and 1999 of biotic diversity within various parts of the watershed (San Francisquito Creek CRMP 2000), and the San Francisquito Creek Bank Stabilization and Revegetation Master Plan contains a discussion of existing habitat conditions between Junipero Serra Boulevard and Highway 101.

Fisheries and Restoration Projects

San Francisquito Creek lies within many jurisdictions and, as a result, there are many entities involved in addressing drainage and environmental issues in the watershed. An attempt to build a consensus among the various interests led to the formation of the San Francisquito Creek Coordinated Resource Management and Planning group. The CRMP was formed in late 1993 and includes more than 80 government agencies and community organizations (Peninsula Conservation Center Foundation 2000).

The CRMP hired a streamkeeper to provide maintenance and administrative support to San Francisquito Creek and prepared the September 2000 draft report Long-term Monitoring and Assessment Plan for the San Francisquito Creek Watershed. The purpose of this plan is to provide a means of identifying and prioritizing information needs and coordinating monitoring and assessment activities. In addition, the CRMP prepared the 1998 Reconnaissance Investigation Report of San Francisquito Creek, summarizing historical floodplain management proposals and discussing feasibility, impacts and preliminary cost estimates of potential projects.

A Joint Powers Authority was formed in May 1999 between the cities of East Palo Alto, Palo Alto, and Menlo Park as well as the Santa Clara Valley Water District and the San Mateo Flood Control District, CRMP and Stanford University. The JPA is examining flood issues within the San Francisquito watershed (San Francisquito Creek CRMP 2000).

The Santa Clara Basin Watershed Management Initiative was established in 1996 by Environmental Protection Agency, the State Water Resources Control Board, and the San Francisco Bay Regional Water Quality Control Board. Water quality issues are being examined in the basin, which includes the San Francisquito Creek watershed (San Francisquito Creek CRMP 2000).

The San Francisquito Creek Bank Stabilization and Revegetation Master Plan is being prepared for a portion of San Francisquito Creek between the Junipero Serra Bridge to University Avenue. It is being sponsored by the cities of Menlo Park, Palo Alto, East Palo Alto, San Mateo County and the Santa Clara County Water District. The report includes mapping of conditions, a conditions report and a master plan report (Cities of Menlo Park, Palo Also, East Palo Alto, San Mateo County, and the Santa Clara County Water District 2000).

The Searsville Lake Sediment Impact Study is being prepared for Stanford University and was to be completed in 2001. This project was to analyze downstream sediment impacts including existing conditions and conditions based on various scenarios of Searsville Dam (San Francisquito Creek CRMP 2000).

A Comparison of Water Quality in Urban and Rural Stormwater Runoff study was funded by San Mateo County and was completed in October 2000. This project compares pollutants in storm water runoff discharged in urban and rural areas of the watershed (San Francisquito Creek CRMP 2000).

The cities of East Palo Alto, Menlo Park, Woodside and Portola Valley and San Mateo County are conducting a study to develop diazinon and sediment reduction plans for San Mateo County jurisdictions as part of the Habitat Enhancement and Flood Hazard Reduction Plan (San Francisquito Creek CRMP 2000).

Tributary

Los Trancos Creek

Potential Impediments to Anadromous Fish Migration

There are a series of weirs that are easily passed on Los Trancos Creek near and under Highway 280. There are no significant barriers between the mouth and the Stanford University Diversion Dam, which has a fish ladder that allows migration to 3.5 miles of potential habitat. However, there are three difficult barriers within this reach of potential habitat, including a 6-foot high concrete flashboard dam 0.1 miles upstream of the Los Trancos Road and Alpine Road intersection. Additionally there is a double box culvert at the Los Trancos Road crossing upstream of Alpine Road, and a box culvert on the Emergency Fire Access Road 0.1 miles downstream of the second Los Trancos Road crossing (Smith and Harden 2001).

General Description

Los Trancos Creek is a tributary of San Francisquito Creek that traverses Santa Clara and San Mateo Counties, entering San Francisquito Creek about river mile 8.3. Los Trancos

Creek is about 8 miles long and its total watershed encompasses about 7.5 square miles, ranging in elevation from 500 feet at its headwaters to 200 feet at its confluence with San Francisquito Creek.

Fish Populations

Steelhead trout are found throughout the Bear Creek watershed, including Los Trancos Creek. One pass electroshocking samples in 1997-1999 found that Los Trancos has an abundance of steelhead 4-5 times higher than that of San Francisquito Creek (Launer and Spain 1998, Launer and Holtgrieve 2000).

Water Quality/Hydrology

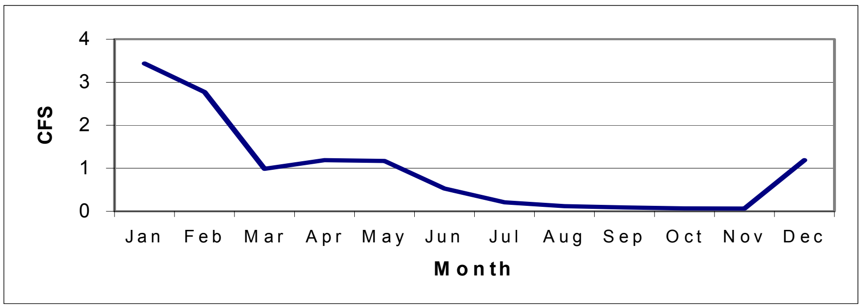

Figure 42. Mean stream flow recorded at USGS gage station 11163000 on Los Trancos Creek at Stanford University from 1930-1941 (USGS 2002).

Streamflow in Los Trancos Creek is highly seasonal and fluctuates sharply in response to winter storms.

The USGS maintained a stream gage station at Stanford University that measured daily streamflow from 1930 to 1941 (USGS 2002).

Habitat Quality

Spawning habitat is common in Los Trancos Creek, and probably provides some fry for stretches of San Francisquito Creek (Harvey and Associates 2001). Rearing habitat also exists in Los Trancos Creek but is constrained by very low late-summer streamflows, even in wet years (Harvey and Associates 2001). Los Trancos Creek downstream of the Stanford Diversion Dam has habitat that has a steep enough gradient to create riffles and runs likely to support moderate insect production and steelhead feeding even under late summer flows (Harvey and Associates 2001). All of the streams in the San Francisquito Creek watershed run turbid with storm flows, but Los Trancos Creek, with a relatively undeveloped watershed, appears to clear most rapidly after storms and has relatively clean substrate (Harvey and Associates 2001).

Habitat Data

Habitat Data for Los Trancos Creek is limited. More information is available concerning habitat data for San Francisquito Creek (see San Francisquito Creek in this report).

Hankinson and Smith from San Jose State University are doing studies to determine genetic relationships among different populations of South San Francisco Bay and Central California Coast steelhead/rainbow trout and the relative influence of hatchery stocking on population genetics. Their study reach includes Los Trancos Creek. According to Geoff Brosseau, Acterra, Palo Alto, California, results from this study should be available in the winter of 2002.

Some habitat data for Los Trancos Creek is available in Harvey and Associates (2001) Searsville Lake Sediment Impact Study: Biotic Resources Synthesis Report. This report is available online at http://facilities.stanford.edu/searsville/draft/biotic_resources.pdf

Long term water quality monitoring has been conducted to characterize wet season conditions at Piers Lane. Data from this study is available from Geoff Brosseau, Acterra, Palo Alto, California.

Fisheries and Restoration Projects

Stanford University is working with the Department of Fish and Game to improve the fish ladder at the Felt Lake Diversion Dam, owned by the University, so that it passes fish more readily. Modifications to the fish ladder are estimated to cost around one million dollars, including planning, permitting, and construction. The implementation schedule is contingent upon the University's ability to secure a funding source to share the cost of the project, but if grant funding is available, the project could begin as soon as spring of 2004.

In March 2002, the San Francisquito Creek Joint Powers Authority submitted a grant proposal to the American Rivers – NOAA Community-Based Restoration Program Partnership on behalf of the Watershed Council to fund a project to remove the Los Trancos/Agosti flashboard dam. The Watershed Council, tentatively, has been awarded $49,000 for the removal of the flashboard dam, with funding contingent upon the development of a conceptual removal plan and cost estimates. DWR's Fish Passage Improvement Program is providing the conceptual plans and cost estimates to help secure funding for the project.

Marsh Creek, Contra Costa County

Potential Impediments to Anadromous Fish Migration

The lower Marsh Creek drop-structure is a grade control structure about 4 miles upstream from the mouth of Marsh Creek at Big Break in the western Delta. This drop structure is the farthest downstream fish passage barrier in the watershed. Marsh Creek Dam is about 7 river miles upstream of the lower Marsh Creek drop-structure, and is also a major fish passage barrier. Sand Creek, a Marsh Creek tributary, contains a drop structure that is about 3 miles upstream of the Marsh Creek drop structure and impedes migration to perennial pools in upper Sand Creek. These pools are on protected land within the East Bay Regional Park District's Black Diamond Mines Regional Park.

General Description

Marsh Creek flows for about 30 miles from its headwaters on the eastern flank of Mt. Diablo to its mouth at Big Break in the western Delta and drains about 128 square miles. Tributaries of Marsh Creek include Briones, Dry, Deer, and Sand Creeks. Marsh Creek and its tributaries flow through a variety of range, farm, and urban lands.

Fish Populations

There is little historical information on salmonid runs in Marsh Creek. Marsh Creek does appear to support reproducing runs of Chinook salmon. Scientists from the Natural Heritage Institute observed adult Chinook salmon below the lower Marsh Creek drop structure in the fall of 2002. In addition, NHI scientists observed and photographed a steelhead trout just below the drop structure (Robins and Cain 2002). There is also an existing population of rainbow trout in the upper watershed (Robins and Cain 2002). NHI scientists also interviewed local anglers along Marsh Creek who have reported that salmon runs have numbered in the hundreds for at least five years (Robins and Cain 2002). These observations have been substantiated by a limited number of fisheries surveys. Slotton and others (1996) reported five juvenile Chinook salmon in lower Marsh Creek during water quality surveys. Additionally, according to Erika Cleugh, DFG biologist, 13 juvenile Chinook salmon (60-80mm) were observed below the lower Marsh Creek drop structure. It is unclear if Chinook salmon are successfully reproducing in Marsh Creek or if the juveniles migrated upstream from the Delta to rear in Marsh Creek.

Water Quality

Several factors have led to the degradation of water quality in the Marsh Creek watershed, including extensive agriculture development, urbanization, and mercury mining activities that began in the 1850s. Marsh Creek Reservoir has been closed to fishing since the mid-1980s due to high concentrations of mercury found in fish both in and upstream of the reservoir.

Hydrology

Streamflows in Marsh Creek fluctuate sharply in response to winter storms. Streamflow is highly seasonal, with the majority of flows occurring in the months of January and February.

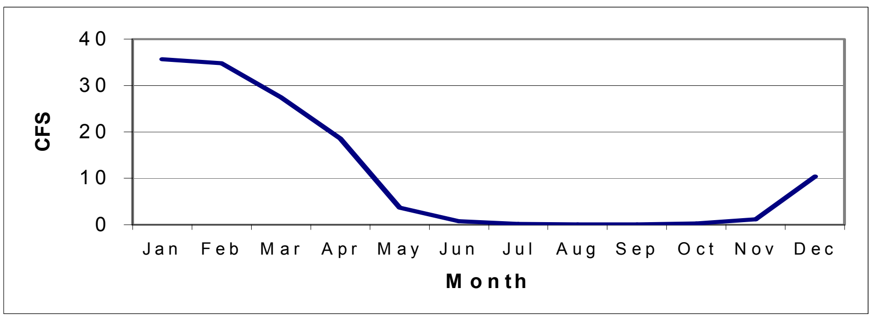

Figure 43. Mean stream flow recorded at USGS stream gage 11337500 on Marsh Creek in Byron from 1953-1983 (USGS 2002).

The USGS has a stream gage in Byron that recorded peak stream flows from 1954-1983, daily stream flows from 1953-1983, and water quality samples in 1970.

Habitat Quality

The lower portion of Marsh Creek has poor habitat due to a lack of vegetation and gravels. There is riprap on the stream bottom that may be used for spawning (NHI 2001). Widespread clearing of vegetation in the 1960s for flood control purposes has created higher water temperatures, lower dissolved oxygen levels, and increased sediment loading (Robins and Cain 2002).

Despite the poor habitat quality in the lower reaches of Marsh Creek, Robins and Cain (2002) reports that multiple areas of suitable spawning habitat for fall-run Chinook salmon exist in the 7 miles of stream between Marsh Creek Dam and the lower Marsh Creek drop structure. This portion of lower Marsh Creek contains numerous regions of gravel and a narrow band of riparian woodland that forms a canopy over the channel that moderates stream temperatures. In addition, potential spawning and over-summering habitat for both steelhead and Chinook is available in the intermediate and upper zones of the watershed. The presence of rainbow trout in the upper Marsh Creek watershed suggests that there are suitable habitat conditions available (Robins and Cain 2002).

Habitat Data

NHI and the Delta Science Center at Big Break prepared The Past and Present Condition of the Marsh Creek Watershed (Robins and Cain 2002). This document contains a discussion of existing habitat conditions.

NHI has also prepared the Corridor Width Report, Parcel Inventory, and Conceptual Stream Corridor Master Plan for Marsh, Sand, and Deer Creeks in Brentwood, California (Walkling 2002). This document contains habitat information as well.

University of California Berkeley graduate students overseen by NHI performed vegetation surveys and pebble count surveys in 2001. Survey information is available from NHI.

The USGS stream gage in Brentwood collected water quality samples in 2000 (USGS 2002).

Fisheries and Restoration Projects

According to Rich Walkling of NHI in Berkeley, the following projects are planned or proposed:

NHI, in partnership with the Delta Science Center and DWR's Fish Passage Improvement Program, received a $6,000 grant in 2002 from American Rivers and NOAA to develop a set of alternative designs for modifying or removing the lower Marsh Creek drop-structure. This project will enable upstream migration of Marsh Creek's existing run of fall-run Chinook salmon and possibly steelhead trout. These designs will be specifically created for incorporation into corridor restoration plans being developed by NHI and the city of Brentwood.

NHI and the Brentwood are semifinalists to receive funds from DWR and California State Parks to purchase the Griffith Parcel; 5 to 11 acres at the confluence of Marsh, Sand, and Deer Creeks. Plans include widening and reshaping the channel to restore meander, improve riparian vegetation, and restore the floodplain.

CALFED has awarded $120,000 to NHI for a watershed assessment, water quality monitoring program, and identification of potential restoration projects.

The California Coastal Conservancy awarded NHI $30,000 for design of a creek corridor protection plan in Brentwood.

2.9 million dollars in CALFED funding is pending for 30 acres of tidal marsh restoration at the mouth of Marsh Creek, water quality monitoring, public outreach and education and restoration of three sites along Marsh Creek in Brentwood.

CALFED has recommended the restoration of Dutch Slough as a directed action. This restoration project involves restoring about 1,000 acres of shallow water tidal marsh at the mouth of Marsh Creek to the east of the current channel.

Contra Costa County Flood Control District has plans for several detention/retention basins in the watershed, including two on Sand Creek, and an expansion of the existing Marsh Creek reservoir a few miles upstream from Brentwood.

The Contra Costa County Flood Control and Water Conservation District plans to remove or redesign the drop structure on Sand Creek to facilitate fish passage if the lower Marsh Creek drop-structure is removed or modified to pass anadromous fish.

San Lorenzo Creek, Alameda County

Potential Impediments to Fish Passage

A variety of flood control and road projects have created potential impediments to fish passage, and have led to fragmentation and isolation of aquatic habitats. Palomares and Cull Creek are not accessible to anadromous steelhead due to the presence of Don Castro Dam, completed in 1965, and Cull Canyon Dam, completed in 1962. Both of these dams are impediments to fish migration, and both reservoirs provide habitat for introduced warm water species, such as bass, that prey on juvenile salmonids.

Only Castro Valley Creek, Crow Creek, and San Lorenzo Creek downstream of Don Castro Dam are accessible to steelhead. However, steelhead using these areas must pass through 3.9-mile concrete channel from near the San Francisco Bay to Foothill Boulevard constructed by the USACE between 1953 and 1962. This channel impedes steelhead passage under most flow conditions (Kobernus 1998). Additionally, in 1972 a 2,000-foot section of Crow Creek just upstream of its confluence with Cull Creek was channelized and covered. This section of altered stream likely impedes migration under most flows (Love 2001). The half-mile concrete culvert under Interstate 580 may also impede fish migration (ACFC & WCD 2002).

General Description

San Lorenzo Creek is about 12.5 miles long with a total watershed area of 48 square miles. The headwaters of San Lorenzo Creek are in the mountains above eastern San Francisco Bay, and it flows through the cities of Hayward and San Leandro, where it then drains into the San Francisco Bay. San Lorenzo Creek has several tributaries including Castro Valley Creek, Chabot Creek, Cull Creek, Crow Creek, Norris Creek, Bolinas Creek, Sulphur Creek, Eden Canyon Creek, Hollis Creek, and Palomares Creek.

Fish Populations

According to the Alameda County Flood Control and Water Conservation District (ACFC & WCD 2002), stream habitat throughout the San Lorenzo Creek watershed supports native fish populations. However, salmonid populations are low. Rainbow trout are present in low numbers, probably as a result of stocking in Don Castro Reservoir (ACFC & WCD 2002). San Lorenzo Creek had highly productive steelhead runs up until the 1950s (ACFC & WCD 2002). Steelhead-spawning habitat had become severely limited as early as 1953 (DFG 1953 as cited in ACFC & WCD 2002).

The DFG performed fisheries surveys in 1960 and 1975. In 1960 DFG biologists surveyed major tributaries of San Lorenzo Creek, including Cull, Palomares, Crow and Eden Canyon Creeks. Rainbow trout or steelhead fry were found in Palomares Creek only. In 1975 DFG biologists surveyed San Lorenzo and Crow Creeks and found resident adult rainbow trout in Bolinas Creek, which is a tributary to Crow Creek, but no juveniles were found. DFG biologists concluded that the steelhead run was extirpated due to channel degradation (DFG 1975). Leidy (1984) performed a survey in 1981 in Palomares Creek and no adult or juvenile salmonids were found. In 1998 two rainbow trout were found during surveys by the San Lorenzo Creek Watershed Project, which is administered by the Alameda County Wide Clean Water Program in partnership with the Natural Resources Conservation Service and the Alameda County Resource Conservation District (Greiner Woodward Clyde 1999).

The ACFC & WCD (2002) reports that there have been numerous reports of adult steelhead and rainbow trout being caught by local anglers or observed in San Lorenzo Creek during wet years from the 1970s to the present. On two occasions, January 2000 and March 2000, ACFC & WCD reported trout in Castro Valley Creek near Knox Street in Hayward. In electroshocking surveys conducted by ACFC & WCD in 2001, three young-of-year rainbow trout were sampled in Crow Creek. Additionally, these surveys gathered adult rainbow trout from Crow Creek and San Lorenzo Creek. Two adult steelhead/rainbow trout were observed in May 2002 in San Lorenzo Creek in the natural section of creek between Foothill Boulevard and 2nd Street in Hayward, according to Emmanuel da Costa, ACFC &WCD, Alameda, California.

Water Quality

Fine sediment loads and episodic poor water quality has limited the numbers and distribution of salmonids in the San Lorenzo watershed. Urbanization has led to increased sediment loading, degraded water quality, altered stream hydrographs, and degraded riparian conditions (ACFC & WCD 2002). Kobernus (1998) found non-point source pollutants such as paint, automobile batteries, concrete, soap, and motor oil in San Lorenzo Creek. Fish kills have been reported from chlorine (DFG 1975) and well-drilling sediments (Kobernus 1998). In addition, potentially harmful levels of diazinon have been recorded in the watershed (ACFC & WCD 1997 as cited in ACFC & WCD 2002).

Water temperatures in the upper reaches above Don Castro Reservoir are generally less than 18° C. Water temperatures remain relatively warm downstream of Don Castro Dam and the Crow Creek confluence, usually exceeding 21° C for as much as 25 percent of the time and often exceeding 24°C. Despite this reach of low-quality habitat, the majority of the watershed has cold water temperatures that can support trout (ACFC & WCD 2002).

Hydrology

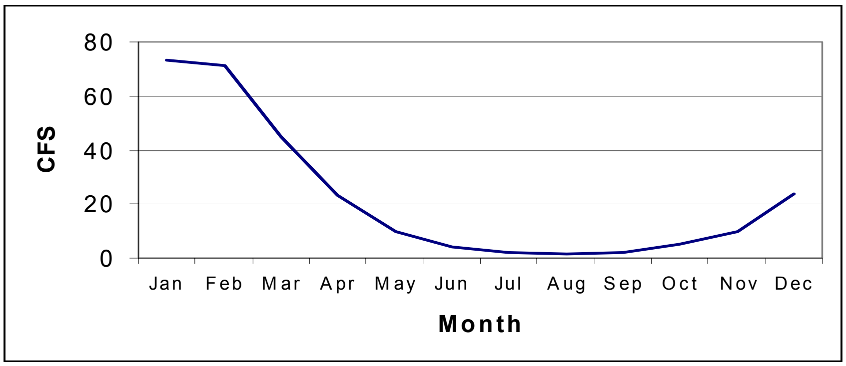

Figure 44. Mean streamflow recorded at USGS stream gage station 11181040 on the San Lorenzo River in San Lorenzo from 1967-2000 (USGS 2002).

Streamflow is highly seasonal and fluctuates sharply in response to winter storms. The USGS maintains several stream gages throughout San Lorenzo Creek watershed. A gage at Don Castro Reservoir recorded peak stream flow from 1981 to 2000, and has recorded daily stream flow and taken water quality samples from 1980 to 2000. A gage in Hayward recorded peak stream flow and daily stream flow from 1940 to 2000 and water quality samples were recorded in 1971. A gage in San Lorenzo recorded peak stream flow from 1968 to 2000, daily stream flow from 1967 to 2000, and water quality samples from 1989-1993. The USGS also operates a stream gage on Crow Creek, immediately upstream of Crow Canyon Road. This gage recorded peak stream flow from 1998-2000, daily stream flow from 1997-2000, and water quality samples from 1999-2000. Cull Creek, which joins Crow Creek immediately downstream of Crow Canyon Road, has a USGS stream gage immediately upstream of Cull Reservoir. This gage has recorded peak stream flow from 1979-2000, daily stream flow from 1978-2000, and water quality samples from 1979-2000. Another USGS station is below the Cull Reservoir Dam. This gage station recorded peak stream flow in 1979, daily stream flow from 1978-1979, and water quality samples in 1979 (USGS 2002).

Habitat Quality

Most of the aquatic habitat in the watershed has been greatly altered as a result of urbanization. Fish habitat in San Lorenzo Creek varies significantly from the upper reaches downstream to the San Francisco Bay. Cold water habitat in the upper parts of the watershed would likely support steelhead/rainbow trout in Palomares Creek, Hollis Creek, Eden Canyon Creek, Norris Creek, upper Crow Creek, upper San Lorenzo Creek, Bolinas Creek, Cull Creek, Castro Valley Creek, Chabot Creek, and Sulphur Creek (ACFC & WCD 2002).

However, most of this habitat is isolated above dams and flood control projects. Relatively cool water exists above Don Castro Dam, but high temperatures due to thermal loading exist downstream of the Don Castro Reservoir. San Lorenzo Creek has been highly modified downstream of Foothill Boulevard and does not support fish communities for most of its length. The upper reaches have few deep pools, but good shelter characteristics while the largest and deepest pools are in the lower reaches. There is good riparian vegetation that contributes to instream and overhead cover in the upper reaches (ACFC & WCD 2002). Lower reaches have lower canopy coverage due to widening of the stream channel.

Crow Creek and two of its tributaries, Norris and Bolinas Creeks, have the greatest potential for suitable habitat and water temperatures to support rainbow trout (ACFC & WCD 2002). Crow Creek is characterized by a good mixture of pools, glides, and riffles and has relatively deep pools and moderate shelter complexity.

Habitat Data

Habitat data for the San Lorenzo watershed is available in the Fish Habitat and Fish Population Assessment For The San Lorenzo Creek Watershed, Alameda County, California (ACFC & WCD 2002).

Fisheries and Restoration Projects

Michael Love and Associates (2001) assessed the 2000-foot long culvert on Crow Creek just upstream of its confluence with Cull Creek for fish passage. According to Paul Modrell of ACFC & WCD in Alameda, Alameda County is planning a road-widening project on Crow Canyon Road and the County Environmental Services Division is interested in modifying the culvert to improve fish passage as mitigation.

Alameda County Public Works Agency is preparing a project that will manage sediment accumulations and future sediment inflow at the Don Castro Reservoir. A pilot project was conducted in 2000 and 15,800 cubic yards of sediment was removed from the delta area. The average annual sediment inflow is 8,600 cubic yards.

The ACFC & WCD and DWR's Fish Passage Improvement Program are assessing the future of Cull Creek Reservoir and Don Castro Reservoir on San Lorenzo Creek. Management options being assessed range from periodic desilting to removal of the dams.

The ACFC & WCD have been awarded about $140,000 from the Coastal Impact Assessment Program to assess the feasibility of restoring the entire 5-mile USACE flood control channel. This assessment will be done soon. The ACFC & WCD have also received a $350,000 grant from the EPA's 319-h program to restore a reach of Palomares Creek and construct a field science center.

The ACFC & WCD is collaborating with Caltrans to have a drop structure removed or modified to allow fish passage into the Eden Creek sub-watershed.

York Creek, Napa County

Potential Impediments to Anadromous Fish Migration

There are two dams and one reservoir on the mainstem of York Creek. There is also a second reservoir in the York Creek drainage on an unnamed tributary stream (DFG 1973). York Dam is impassable and is the upstream limit of anadromous fish migration. The lower diversion dam, downstream of York Dam, is passable at high flows (DFG 2000b).

General Description

York Creek is a west side tributary to the Napa River at River Mile 36. It is about 4.5 miles long and drains about 5 square miles. The creek originates in the western hills of the Napa Valley at an elevation of about 1,800 feet. It flows through a narrow canyon, into the Napa Valley, through the town of St. Helena and enters the Napa River at an elevation of 220 feet. Upstream of the Highway 29 crossing the stream drops in elevation an average of 230 feet per mile. Downstream of the Highway 29 crossing the stream is less steep and only loses 30 feet per mile (DFG 1974).

Fish Populations

York Creek was historically a steelhead stream and today supports a run of steelhead below Saint Helena Upper Dam (York Dam) as well as a population of rainbow trout in the 2 miles of habitat above the dam. The most recent survey of York Creek was done in September 2000. The creek was electrofished from the base of the dam to about a mile downstream to a driveway that leads to the city of St. Helena water tanks. Juvenile steelhead were found to be abundant and were distributed uniformly. Most of the fish were young-of-year with fewer fish being yearlings and older. In the mile sampled, about 200 fish were seen (DFG 2000a). A May 1986 DFG survey of the creek above York Dam revealed 10 rainbow trout in the 500-foot long reach surveyed (DFG 1986). DFG stream surveys in1974 and 1975 also report steelhead in York Creek. In 1975 there were estimated to be 20 *Oncorhynchus mykiss* every 100 feet from York Dam upstream to the creek's headwaters (DFG 1975). In 1974, below the dam, young-of-year steelhead trout were estimated to exceed 100 per 100 feet of stream (DFG 1974).

Water Quality

Water quality in York Creek has not been studied extensively. The water temperature is generally cold but flow may not be adequate below York Dam. Available temperature data include DFG fish surveys in April 1986 and September 2000. Water temperature was 55° F above the dam in the 1986 survey and 59° F below the dam in the 2000 survey. There have been several sediment spills in York Creek that resulted in fish kills. Other than these spills there are no documented water quality problems in the creek.

Hydrology

A 1993 DFG stream survey reported flows ranging from 0.1 to 1.4 cfs with an average flow of 0.56 cfs below York Dam on 9 Jul (DFG 1973). In a 1974 DFG stream survey, flow above the dam was estimated at 1.5 cfs. Immediately below the dam, flow was 1.0 cfs and 1,000 feet above Highway 29, the flow was 0.5 cfs. Below Highway 29, flows were intermittent during this 13 Jun survey (DFG 1974). In a 1975 stream survey by DFG the flow at York Dam was determined to be 1.0 cfs on 5 Aug (DFG 1975).

Habitat Quality

The habitat in York Creek can be divided into three reaches, from the confluence with the Napa River upstream to Highway 29, from Highway 29 upstream to York Saint Helena Upper Dam, and from the dam upstream to the headwaters. Below Highway 29 there is little cover and annual grasses are the predominant vegetation. Above the Highway 29 crossing "dense stands of vegetation border the stream" providing adequate cover (DFG 1974). There are also boulders and undercut banks that provide shade and shelter in this reach (DFG 1974). In this area, the riffle to pool ratio is 1:1 and the substrate is 60 percent gravel (DFG 1973). Above the dam there is high quality steelhead habitat. The riffle-to-pool ratio was 3:1 and there was 100 percent cover over 90 percent of the pools in this upper reach in a 1975 DFG survey. About 30-40 percent of the streambed above York Dam was considered good spawning habitat because of the good gravel substrate. Significant logjams were observed in the creek during a 1975 DFG survey. The status of those jams is unknown. The most recent survey of the creek was done on 27 Sep 2000. A large number of steelhead were observed below the dam at this time. Water temperature was 59° F and "the overhanging riparian tree vegetation provided about 75 percent shade cover" (DFG 2000b) over the surveyed portion of the creek. There was also good shelter and, according to the DFG survey by Fishery Biologist Bill Cox, the area below the dam "provided habitat with a very high potential to support steelhead" (Cox 2000). Gravel was limited, but present, below the dam (DFG 2000b).

Habitat Data

There are three published DFG stream surveys of York Creek available in the Region III office. One was done in 1973 from the mouth of the creek up to York Dam. The second one, done in 1974, covered the same reach. The third survey, done in 1975, covered the creek from the dam upstream to its headwaters. These surveys contain flow and temperature data as well as information about what fish were present and descriptions of the habitat at the time of the surveys. There is no flow gage on the creek.

Fishery and Restoration Projects

As a result of a complaint filed by the DFG, the city of St. Helena has agreed to remove York Dam. The city is obtaining the required permit from the U.S. Army Corps of Engineers. The estimated cost of removal is $500,000 (DFG 2000a). DWR's Fish Passage Improvement Program began the initial environmental and engineering tasks for removal of the dam. The dam removal project has been turned over to ACOE by the city of St. Helena for further study and evaluations for future removal efforts.

DWR's Fish Passage Improvement Program is finalizing plans and environmental documentation for improving fish passage at the lower diversion dam downstream of York Dam. The diversion dam is owned by the city of St. Helena, and the project is expected to be completed in 2003.

Figure 21

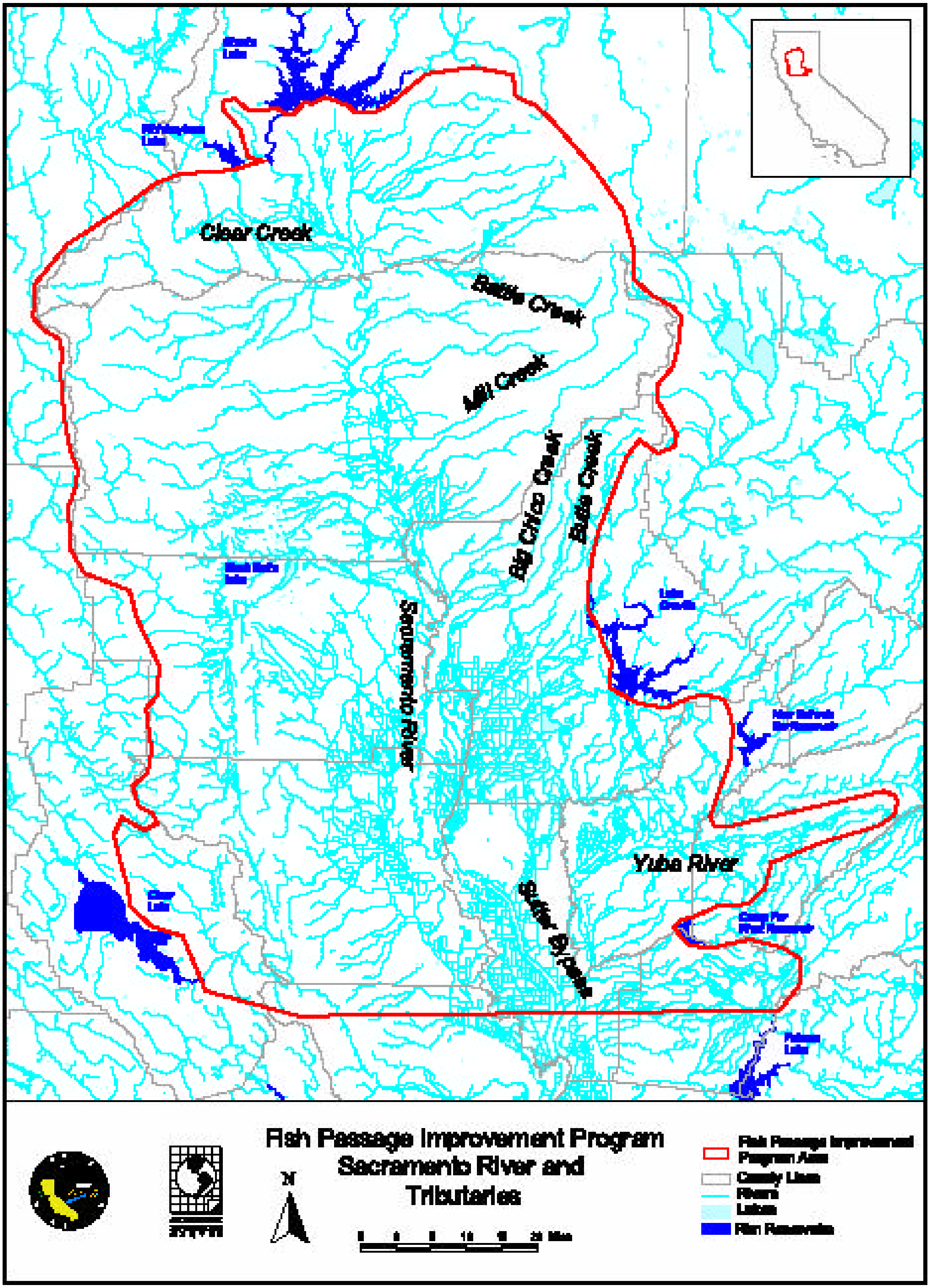
Clear Creek
Battle Creek
Mill Creek
Big Chico Creek
Butte Creek
Sacramento River
Yuba River
Feather River
Fish Passage Improvement Program
Sacramento River and
Tributaries
N

Figure 22

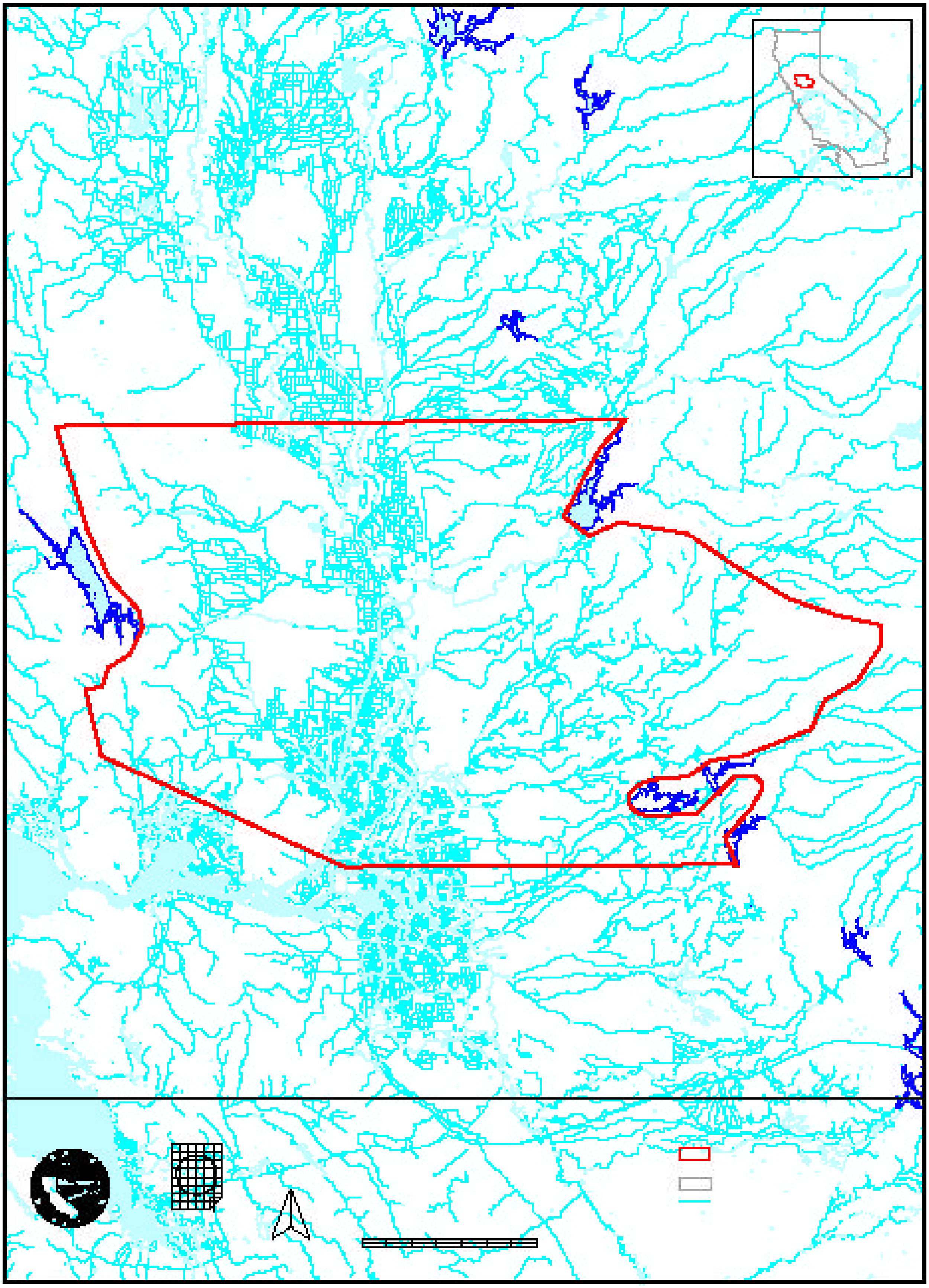

Figure 23

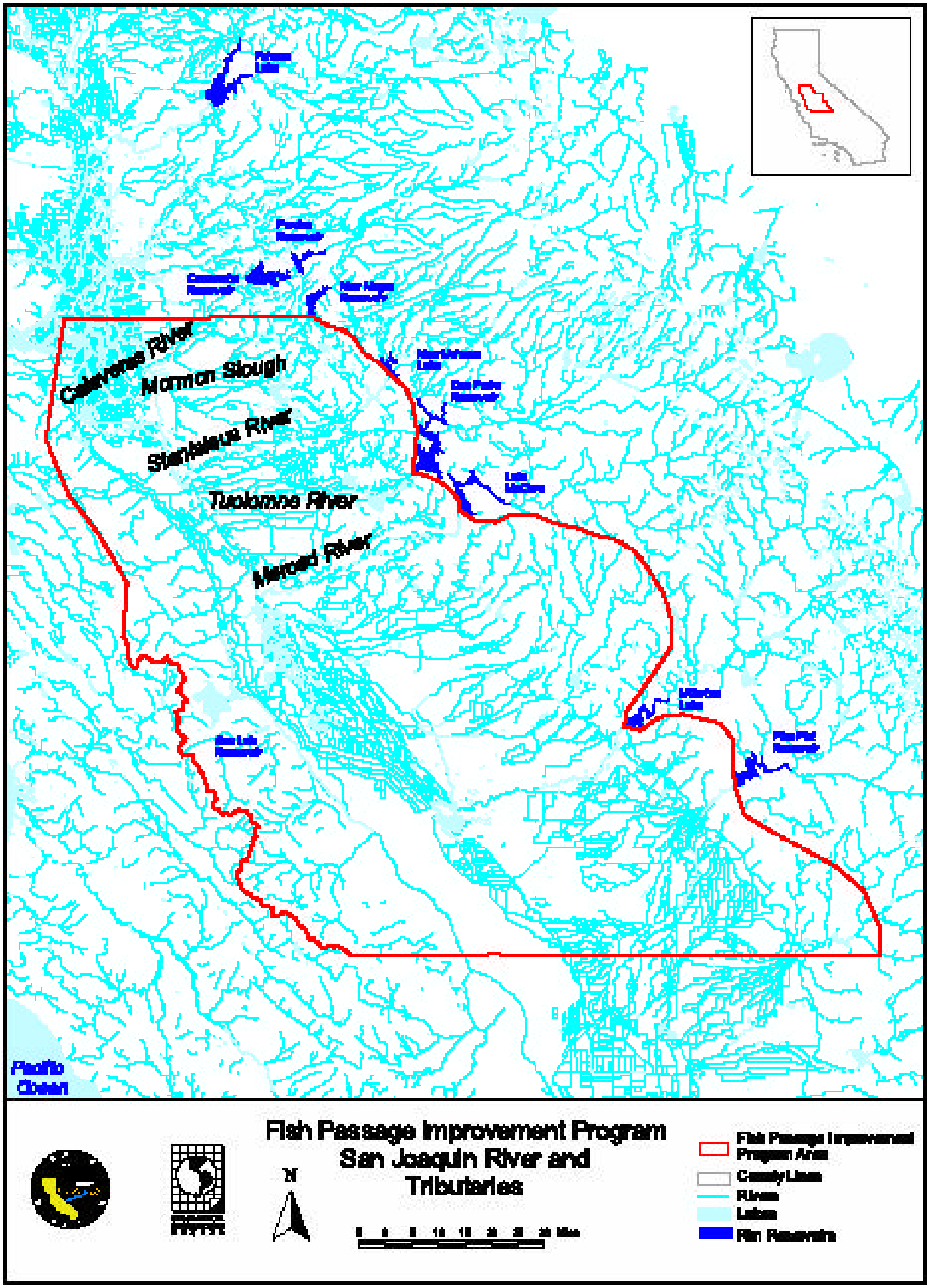
Calaveras River
Mormon Slough
Stanislaus River
Tuolumne River
Merced River
Pacific Ocean
Fish Passage Improvement Program
San Joaquin River and
Tributaries
N
Fish Passage Improvement Program Area
County Lines
Rivers
Lakes
Rim Reservoirs

Figure 24

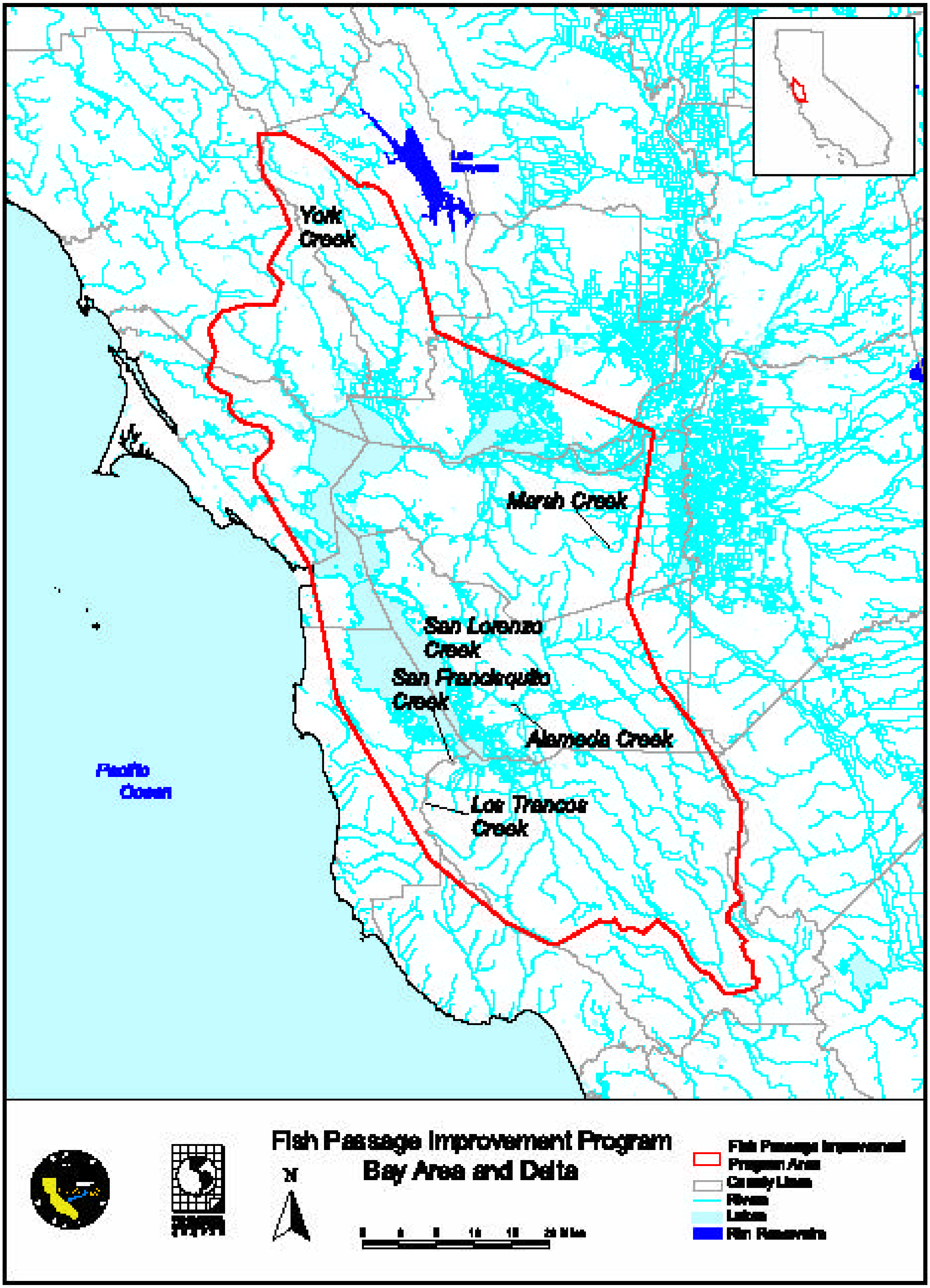
York Creek
Marsh Creek
San Lorenzo Creek
San Francisquito Creek
Alameda Creek
Los Trancos Creek
Pacific Ocean
Fish Passage Improvement Program
Bay Area and Delta
N

Table 3-2. Sacramento River Matrix

River Name	Critical Habitat	Stream Type	Stream Habitat Survey Data	Stream Temperature Data	Gravel Survey Data	Vegetation Survey Data	Redd Survey Data	Steelhead Surveys Pre-1960	Steelhead Surveys 1960-1980	Steelhead Surveys 1981-2000	Salmon Surveys Pre-1960	Salmon Surveys 1960-1980	Salmon Surveys 1981-2000	Streamflow Data	Flow Adequate Steelhead	Flow Adequate Fall Run	Flow Adequate Winter Run	Flow Adequate Spring Run	Flow Adequate Late-Fall Run
Battle Creek	Yes	Perennial	X	X			X				X	X	X	X	X	X	X	X	X
Big Chico Creek	Yes	Perennial	X	X	X	X	X				X	X	X	X				X	X
Butte Creek	Yes	Perennial		X			X				X	X	X	X				X	X
Clear Creek	Yes	Perennial	X	X	X	X	X				X	X	X	X	X	X		X	X
Mill Creek	Yes	Perennial		X			X	X	X	X	X	X	X	X					
Sacramento River	Yes	Perennial	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Yuba River	Yes	Perennial		X					X	X	X	X	X	X					

Table 3-3. Sacramento River Passage Matrix

River Name	Barrier Name	Description	River Mile	Sequence	Passage Type	Functional Status	Enhancement	Species	Up Passage	Down Passage
Battle Creek, North Fork	Wildcat Dam	Dam	2.4	1	Pool & Weir	Operating	No	Spring-run Chinook Salmon	Yes	Yes
								Winter-run Chinook Salmon	Yes	Yes
								Late-Fall Run Chinook Salmon	Yes	No
								Fall-run Chinook Salmon	Yes	No
								Central Valley Steelhead	Yes	Yes
	Eagle Canyon Dam	Dam	5.1	2	Alaska Steep Pass	Non-operating	Yes	Winter-run Chinook Salmon	Yes	Yes
								Spring-run Chinook Salmon	Yes	Yes
								Central Valley Steelhead	Yes	Yes
	North Battle Creek Feeder Diversion	Dam	9.2	3	Alaska Steep Pass	Operating	Yes	Central Valley Steelhead	Yes	Yes
								Spring-run Chinook Salmon	Yes	Yes
Battle Creek, South Fork	Coleman Diversion Dam	Dam	2.5	1	Alaska Steep Pass	Operating	No	Spring-run Chinook Salmon	Yes	Yes
								Winter-run Chinook Salmon	Yes	Yes
								Central Valley Steelhead	Yes	Yes
								Late-Fall Run Chinook Salmon	Yes	Yes
								Fall-run Chinook Salmon	Yes	Yes
	Inskip Diversion Dam	Dam	8	2	Alaska Steep Pass	Operating	Yes	Fall-run Chinook Salmon	Yes	No
								Late-Fall Run Chinook Salmon	Yes	No
								Winter-run Chinook Salmon	Yes	Yes
								Spring-run Chinook Salmon	Yes	Yes

Table 3-3 (continued). Sacramento River Passage Matrix

River Name	Barrier Name	Description	River Mile	Sequence	Passage Type	Functional Status	Enhancement	Species	Up Passage	Down Passage
								Central Valley Steelhead	Yes	Yes
	South Diversion Dam	Dam	13.9	3	Denil	Operating	No	Spring-run Chinook Salmon	Yes	Yes
								Central Valley Steelhead	Yes	Yes
								Winter-run Chinook Salmon	Yes	Yes
Ripley Creek	Lower Ripley Creek Diversion Dam	Dam	1	5	None	None	No	Central Valley Steelhead	Yes	Yes
Soap Creek	Soap Creek Diversion Dam	Dam	1	6	None	None	No	Central Valley Steelhead	No	No
Big Chico Creek	Bear Hole	Natural	13.3	5	None	None	No	Central Valley Steelhead	Yes	Yes
								Winter-run Chinook Salmon	Yes	Yes
								Spring-run Chinook Salmon	Yes	Yes
	Iron Canyon	Natural	14.2	6	Pool & Weir	Non-operating	Yes	Central Valley Steelhead	Yes	Yes
								Winter-run Chinook Salmon	Yes	Yes
								Spring-run Chinook Salmon	Yes	Yes
Butte Creek	Tarke Weir	Weir	3.6	2	None	None	No	Fall-run Chinook Salmon	Yes	Yes
								Late-Fall Run Chinook Salmon	Yes	Yes
								Spring-run Chinook Salmon	Yes	Yes
								Sacramento splittail	Yes	Yes
								Central Valley Steelhead	Yes	Yes
	Drivers Cut Weir	Weir	5.5	4	None	None	No	Fall-run Chinook Salmon	Yes	Yes
								Sacramento splittail	Yes	Yes
								Central Valley Steelhead	Yes	Yes

Table 3-3 (continued). Sacramento River Passage Matrix

River Name	Barrier Name	Description	River Mile	Sequence	Passage Type	Functional Status	Enhancement	Species	Up Passage	Down Passage
								Spring-run Chinook Salmon	Yes	Yes
								Late-Fall Run Chinook Salmon	Yes	Yes
	Drumheller Slough	Culvert	8.3	5	None	None	No	Spring-run Chinook Salmon	Yes	Yes
								Late-Fall Run Chinook Salmon	Yes	Yes
								Central Valley Steelhead	Yes	Yes
								Sacramento splittail	Yes	Yes
								Fall-run Chinook Salmon	Yes	Yes
	White Mallard Outfall	Weir	10.2	6	None	None	No	Central Valley Steelhead	Yes	Yes
								Late-Fall Run Chinook Salmon	Yes	Yes
								Sacramento splittail	Yes	Yes
								Spring-run Chinook Salmon	Yes	Yes
								Fall-run Chinook Salmon	Yes	Yes
	White Mallard Dam	Weir	12	7	Pool & Weir	Non-operating	Yes	Fall-run Chinook Salmon	Yes	Yes
								Late-Fall Run Chinook Salmon	Yes	Yes
								Spring-run Chinook Salmon	Yes	Yes
								Central Valley Steelhead	Yes	Yes
								Sacramento splittail	Yes	Yes
Cherokee Canal	Morton Weir	Weir	0.9	3	None	None	No	Fall-run Chinook Salmon	Yes	Yes
								Spring-run Chinook Salmon	Yes	Yes

Table 3-3 (continued). Sacramento River Passage Matrix

River Name	Barrier Name	Description	River Mile	Sequence	Passage Type	Functional Status	Enhancement	Species	Up Passage	Down Passage
								Sacramento splittail	Yes	Yes
								Central Valley Steelhead	Yes	Yes
								Late-Fall Run Chinook Salmon	Yes	Yes
	Mile Long Canal	Weir	1	2	None	None	No	Central Valley Steelhead	Yes	Yes
								Sacramento splittail	Yes	Yes
								Spring-run Chinook Salmon	Yes	Yes
								Late-Fall Run Chinook Salmon	Yes	Yes
								Fall-run Chinook Salmon	Yes	Yes
Sanborn Slough	North Weir	Weir	1.7	2	None	None	No	Spring-run Chinook Salmon	Yes	Yes
								Late-Fall Run Chinook Salmon	Yes	Yes
								Central Valley Steelhead	Yes	Yes
								Sacramento splittail	Yes	Yes
								Fall-run Chinook Salmon	Yes	Yes
	End Weir	Weir	2.8	1	None	None	No	Fall-run Chinook Salmon	Yes	Yes
								Central Valley Steelhead	Yes	Yes
								Spring-run Chinook Salmon	Yes	Yes
								Late-Fall Run Chinook Salmon	Yes	Yes
								Sacramento splittail	Yes	Yes
Sutter Bypass/East Canal	Nelson Slough Weir	Weir	8.3	1	None	None	No	Sacramento splittail	Yes	Yes

Table 3-3 (continued). Sacramento River Passage Matrix

River Name	Barrier Name	Description	River Mile	Sequence	Passage Type	Functional Status	Enhancement	Species	Up Passage	Down Passage
								Central Valley Steelhead	Yes	Yes
								Winter-run Chinook Salmon	Yes	Yes
								Spring-run Chinook Salmon	Yes	Yes
								Late-Fall Run Chinook Salmon	Yes	Yes
								Fall-run Chinook Salmon	Yes	Yes
	Willow Slough	Weir	9.6	2	Denil	Operating	Yes	Fall-run Chinook Salmon	Yes	Yes
								Winter-run Chinook Salmon	Yes	Yes
								Late-Fall Run Chinook Salmon	Yes	Yes
								Spring-run Chinook Salmon	Yes	Yes
								Central Valley Steelhead	Yes	Yes
								Sacramento splittail	Yes	Yes
	Sutter Bypass Weir #2	Weir	25	3	Pool & Weir	Operating	Yes	Central Valley Steelhead	Yes	Yes
								Sacramento splittail	Yes	Yes
								Winter-run Chinook Salmon	Yes	Yes
								Spring-run Chinook Salmon	Yes	Yes
								Late-Fall Run Chinook Salmon	Yes	Yes
								Fall-run Chinook Salmon	Yes	Yes
Sutter Bypass/West Canal	Sutter Bypass Weir #1	Weir	19.9	1	Vertical Slot	Operating	Yes	Late-Fall Run Chinook Salmon	Yes	Yes
								Winter-run Chinook Salmon	Yes	Yes

Table 3-3 (continued). Sacramento River Passage Matrix

River Name	Barrier Name	Description	River Mile	Sequence	Passage Type	Functional Status	Enhancement	Species	Up Passage	Down Passage
								Spring-run Chinook Salmon	Yes	Yes
								Central Valley Steelhead	Yes	Yes
								Sacramento splittail	Yes	Yes
								Fall-run Chinook Salmon	Yes	Yes
	Guisti Weir	Weir	22.5	2	Bypass	Operating	Yes	Late-Fall Run Chinook Salmon	Yes	Yes
								Winter-run Chinook Salmon	Yes	Yes
								Fall-run Chinook Salmon	Yes	Yes
								Spring-run Chinook Salmon	Yes	Yes
								Central Valley Steelhead	Yes	Yes
								Sacramento splittail	Yes	Yes
	Sutter Bypass Weir #3	Weir	25	3	None	None	No	Spring-run Chinook Salmon	Yes	Yes
								Winter-run Chinook Salmon	Yes	Yes
								Late-Fall Run Chinook Salmon	Yes	Yes
								Fall-run Chinook Salmon	Yes	Yes
								Sacramento splittail	Yes	Yes
								Central Valley Steelhead	Yes	Yes
	Sutter Bypass Weir #5	Weir	28.9	4	None	None	Yes	Spring-run Chinook Salmon	Yes	Yes
								Winter-run Chinook Salmon	Yes	Yes
								Sacramento splittail	Yes	Yes

Table 3-3 (continued). Sacramento River Passage Matrix

River Name	Barrier Name	Description	River Mile	Sequence	Passage Type	Functional Status	Enhancement	Species	Up Passage	Down Passage
								Central Valley Steelhead	Yes	Yes
								Fall-run Chinook Salmon	Yes	Yes
								Late-Fall Run Chinook Salmon	Yes	Yes
	East-West Diversion Weir	Weir	29.8	5	None	None	Yes	Sacramento splittail	Yes	Yes
								Winter-run Chinook Salmon	Yes	Yes
								Fall-run Chinook Salmon	Yes	Yes
								Late-Fall Run Chinook Salmon	Yes	Yes
								Spring-run Chinook Salmon	Yes	Yes
								Central Valley Steelhead	Yes	Yes
Clear Creek	Saeltzer Dam	Dam	6.3	2	Pool & Weir	Non-operating	Yes	Central Valley Steelhead	Yes	Yes
								Fall-run Chinook Salmon	Yes	Yes
								Late-Fall Run Chinook Salmon	Yes	Yes
Mill Creek	Clough Dam	Dam	4.2	2	None	None	No	Central Valley Steelhead	Yes	Yes
								Spring-run Chinook Salmon	Yes	Yes
								Winter-run Chinook Salmon	Yes	Yes
								Fall-run Chinook Salmon	Yes	Yes
Yuba River	Daguerre Point Dam	Dam	11.5	1	Pool & Weir	Operating	No	Fall-run Chinook Salmon	Yes	Yes
								Late-Fall Run Chinook Salmon	Yes	Yes
								Spring-run Chinook Salmon	Yes	Yes

Table 3-3 (continued). Sacramento River Passage Matrix

River Name	Barrier Name	Description	River Mile	Sequence	Passage Type	Functional Status	Enhancement	Species	Up Passage	Down Passage
								Central Valley Steelhead	Yes	Yes
								Green sturgeon	Yes	No
	Daguerre Point Dam	Dam	11.5	1	Pool & Weir	Non-operating	Yes	Spring-run Chinook Salmon	Yes	Yes
								Late-Fall Run Chinook Salmon	Yes	Yes
								Central Valley Steelhead	Yes	Yes
								Green sturgeon	Yes	No
								Fall-run Chinook Salmon	Yes	Yes
	Englebright	Variable Radius	24	2	None	None	No	Spring-run Chinook Salmon	Yes	No
								Late-Fall Run Chinook Salmon	Yes	No
								Fall-run Chinook Salmon	Yes	No
								Central Valley Steelhead	Yes	No

All structures are listed in order from downstream to upstream by river.

Species indicates that the species has been documented in the stream.

Upstream Passage indicates weather or not the species can traverse the structure in the upstream direction (yes does not mean that passage is possible at all flows).

Down Passage indicates weather or not juvenile fishes can traverse the structure in the downstream direction.

Table 3-4. Lower Sacramento River Matrix

River Name	Critical Habitat	Stream Type	Stream Habitat Survey Data	Stream Temperature Data	Gravel Survey Data	Vegetation Survey Data	Redd Survey Data	Steelhead Surveys Pre-1960	Steelhead Surveys 1960-1980	Steelhead Surveys 1981-2000	Salmon Surveys Pre-1960	Salmon Surveys 1960-1980	Salmon Surveys 1981-2000	Streamflow Data	Flow Adequate Steelhead	Flow Adequate Fall Run	Flow Adequate Winter Run	Flow Adequate Spring Run	Flow Adequate Late-Fall Run
Cosumnes River	Yes	Seasonal	X	X	X		X			X	X	X	X	X	X	X			
Dry Creek	Yes	Perennial	X			X				X			X	X					
Miners Ravine	Yes	Perennial	X			X													
Murphy Creek	Yes	Perennial	X	X	X	X	X			X		X	X			X			
Putah Creek	Yes	Perennial	X			X		X	X	X	X	X	X	X	X	X			
Sacramento River	Yes	Perennial	X	X		X				X		X	X	X	X	X	X	X	X

Table 3-5. Lower Sacramento River Passage Matrix

River Name	Barrier Name	Description	River Mile	Sequence	PassageType	Functional Status	Enhancement	Species	Up Passage	Down Passage
Cosumnes River	Consumnes River Road Crossing	Road	7	1	Other, upstream	Operating	No	Central Valley Steelhead	Yes	Yes
								Fall-run Chinook Salmon	Yes	Yes
	Hopland Ranch Dam	Dam	16	2	None	None	Yes	Fall-run Chinook Salmon	Yes	Yes
								Central Valley Steelhead	Yes	Yes
	Blodgett Dam	Dam	23	3	Other, upstream	Operating	Yes	Fall-run Chinook Salmon	Yes	Yes
								Central Valley Steelhead	Yes	Yes
	Granlees	Gravity	34	4	Ladder, upstream	Operating	Yes	Fall-run Chinook Salmon	Yes	Yes
								Central Valley Steelhead	Yes	Yes
	Granlees	Gravity	34	4	Screened intake, downstream	Operating	No	Fall-run Chinook Salmon	Yes	Yes
								Central Valley Steelhead	Yes	Yes
Dry Creek	Hayer Dam	Dam	2.6	1	None	None	No	Fall-run Chinook Salmon	Yes	Yes
								Central Valley Steelhead	Yes	Yes
	Pipeline Crossing	Pipeline		1	None	None	No	Fall-run Chinook Salmon	Yes	Yes
								Central Valley Steelhead	Yes	Yes
Secret Ravine	Triple Pipeline Crossing	Pipeline	0.1	1	None	None	No	Fall-run Chinook Salmon	Yes	Yes
								Central Valley Steelhead	Yes	Yes
Miners Ravine	Cottonwood Dam	Dam	7.4	1	None	None	No	Fall-run Chinook Salmon	No	No
								Central Valley Steelhead	No	No
Murphy Creek	Sparrowk Dam	Dam					Yes	Fall-run chinook Salmon and Central Valley Steelhead	No	No
	Road Crossing	Road					Yes	Fall-run chinook Salmon and Central Valley Steelhead		
Putah Creek	Bypass Check Dam	Dam	0	1	None	None	Yes	Fall-run Chinook Salmon	Yes	Yes
								Central Valley Steelhead-Anecdotal	UNK	UNK

Table 3-5 (continued). Lower Sacramento River Passage Matrix

River Name	Barrier Name	Description	River Mile	Sequence	PassageType	Functional Status	Enhancement	Species	Up Passage	Down Passage
	Ag Road on Putah Creek	Culvert	2	2	Culvert, downstream	Operating	No	Fall-run Chinook Salmon	Yes	Yes
								Central Valley Steelhead-Anecdotal	Yes	Yes
	Winters Percolation Dam	Dam	20	3	None	None	No	Fall-run Chinook Salmon	Yes	Yes
								Central Valley Steelhead-Anecdotal	Yes	Yes
	Putah Diversion Dam	Dam	24	4	None	None	No	Fall-run Chinook Salmon	No	No
								Central Valley Steelhead	No	No
Sacramento River	Fremont Weir	Flood control weir	77		Ladder, upstream	Non-operating	Yes	Fall-run Chinook Salmon	No	No
								Late Fall-run Chinook Salmon	No	No
								Winter-run Chinook Salmon	No	No
								Spring -run Chinook Salmon	No	No
								Green Sturgeon	No	No
								Central Valley Steelhead	No	No
								Sacramento Splittail	No	No

All structures are listed in order from downstream to upstream by river.

Species indicates that the species has been documented in the stream.

Upstream Passage indicates weather or not the species can traverse the structure in the upstream direction (yes does not indicate that passage is possible at all flows). UNK indicates unknown.

Down Passage indicates weather or not juvenile fishes can traverse the structure in the downstream direction. UNK indicates unknown.

Table 3-6. San Joaquin River Matrix

River Name	Critical Habitat	Stream Type	Stream Habitat Survey Data	Stream Temperature Data	Gravel Survey Data	Vegetation Survey Data	Redd Survey Data	Steelhead Surveys Pre-1960	Steelhead Surveys 1960-1980	Steelhead Surveys 1981-2000	Salmon Surveys Pre-1960	Salmon Surveys 1960-1980	Salmon Surveys 1981-2000	Streamflow Data	Flow Adequate Steelhead	Flow Adequate Fall Run	Flow Adequate Winter Run	Flow Adequate Spring Run	Flow Adequate Late-Fall Run
Calaveras River	Yes	Seasonal	X		X				X	X		X	X	X					
Mormon Slough/Stockton Diverting Canal	Yes	Seasonal																	
Merced River	Yes	Perennial	X	X	X	X					X	X	X	X		X			
Stanislaus River	Yes	Perennial	X	X	X	X	X			X	X	X	X	X		X			
Tuolumne River	Yes	Perennial	X	X	X	X	X	X			X	X	X	X		X			

Table 3-7. San Joaquin Passage Matrix

River Name	Barrier Name	Description	River Mile	Sequence	PassageType	Functional Status	Enhancement	Species	Up Passage	Down Passage
Calaveras River	McAllen Dam	Dam	6.9	1				Fall-run chinook Salmon and Central Valley Steelhead		
	Cherryland Dam	Dam	7.9	2				Fall-run chinook Salmon and Central Valley Steelhead		
	Solari Dam	Dam	10	3				Fall-run chinook Salmon and Central Valley Steelhead		
	Pezzi Dam	Dam	12	4				Fall-run chinook Salmon and Central Valley Steelhead		
	Murphy Dam	Dam	12	5				Fall-run chinook Salmon and Central Valley Steelhead		
	Eight Mile Dam	Dam	15	6				Fall-run chinook Salmon and Central Valley Steelhead		
	Tully Dam	Dam	17	7				Fall-run chinook Salmon and Central Valley Steelhead		
	Clements Dam	Dam	21	8				Fall-run chinook Salmon and Central Valley Steelhead		
	Calaveras Head Works	Dam	25	9				Fall-run chinook Salmon and Central Valley Steelhead		
	Calaveras Head Works	Dam	25	9				Fall-run chinook Salmon and Central Valley Steelhead		
	Bellota Weir	Weir	25	10	Temporary ladder	Under evaluation	No	Fall-run chinook Salmon and Central Valley Steelhead	yes	No
	McGurk Earth Dam	Dam	27	11				Fall-run chinook Salmon and Central Valley Steelhead		
	Wilsons Crossing Dam	Dam	28	12				Fall-run chinook Salmon and Central Valley Steelhead		
	Williams Crossing	Dam	31	13				Fall-run chinook Salmon and Central Valley Steelhead		
	Road	Road	33	14				Fall-run chinook Salmon and Central Valley Steelhead		
	Dam	Dam	43	15				Fall-run chinook Salmon and Central Valley Steelhead		
Calaveras River Trib	Davis No 2	Earth	0.1	1						
	Bevanda	Earth	5.3	2						
	Foothill Ranch	Earth	5.5	3						
Mormon Slough	Budiselich Dam	Dam	2	1				Fall-run chinook Salmon and Central Valley Steelhead		
	Main Street Dam	Dam	4.9	2				Fall-run chinook Salmon and Central Valley Steelhead		
	Panella Dam	Dam	6.6	3				Fall-run chinook Salmon and Central Valley Steelhead		

Table 3-7 (continued). San Joaquin Passage Matrix

River Name	Barrier Name	Description	River Mile	Sequence	PassageType	Functional Status	Enhancement	Species	Up Passage	Down Passage
	Caprini Crossing	Dam	7.1	4				Fall-run chinook Salmon and Central Valley Steelhead		
	Lavaggi Dam	Dam	7.4	5				Fall-run chinook Salmon and Central Valley Steelhead		
	Hogan Crossing	Dam	8.4	6				Fall-run chinook Salmon and Central Valley Steelhead		
	McClean Dam	Dam	8.5	7				Fall-run chinook Salmon and Central Valley Steelhead		
	Fujinaka Crossing	Dam	9.5	8				Fall-run chinook Salmon and Central Valley Steelhead		
	Prato Dam	Dam	10	9				Fall-run chinook Salmon and Central Valley Steelhead		
	Mormon Slough Tressel	Road	11	10				Fall-run chinook Salmon and Central Valley Steelhead		
	Piazza Dam	Dam	12	11				Fall-run chinook Salmon and Central Valley Steelhead		
	Bonomo Dam	Dam	12	12				Fall-run chinook Salmon and Central Valley Steelhead		
	Hosie Low Water Crossing	Road	13	13				Fall-run chinook Salmon and Central Valley Steelhead		
	Hosie Dam	Dam	13	14				Fall-run chinook Salmon and Central Valley Steelhead		
	Avansino Dam	Dam	14	15				Fall-run chinook Salmon and Central Valley Steelhead		
	Fine Dam	Dam	15	16				Fall-run chinook Salmon and Central Valley Steelhead		
	Motoide Dam	Dam	16	17				Fall-run chinook Salmon and Central Valley Steelhead		
	Watkins Crossing	Road	17	18				Fall-run chinook Salmon and Central Valley Steelhead		
Mormon Slough Trib	Gilmore	Earth	5.5	1						
Mosher Creek	Leffler Dam	Dam	9.9	1						

Table 3-7 (continued). San Joaquin Passage Matrix

River Name	Barrier Name	Description	River Mile	Sequence	PassageType	Functional Status	Enhancement	Species	Up Passage	Down Passage
	Cotta & Ferreira Concrete Crossing	Road	11	2						
	Cotta & Ferreira Dirt Crosing	Road	11	3						
	Cotta & Ferreira Dam	Dam	11	4						
	Cortopassi Dam #2	Dam	13	5						
	Cortopassi Dam #1	Dam	13	6						
	Bear Creek Check & Spill S.J.F.C.	Dam	13	7						
	Diversion Dam/Mosher Creek	Dam	13	8						
	Lyons Dam	Dam	15	9						
	Gurnsey Crossing	Road	20	10						
	Webster Dam	Dam	21	11						
New Channel of Potter Creek	Cliff Motoike Sack Dam	Dam	2	1						
	Leonardini Dirt Crossing	Road	3.6	2						
	Billingmeier Dam	Dam	3.9	3						
Potter Creek	Fowler Bridge	Dam	0							
	Sam Motoike	Road	0							
	McCarthy Crossing	Dam	0							
	Delucci Crossing	Dam	0.9							
	Delucci #2 Crossing	Dam	1.3							
	Stagnaro Crossing	Dam	3.1							
	Cavagnaro Crossing	Dam	3.6							
	Gonser Crossing	Dam	3.7							
	Sanguineti Dam	Dam	5							
	Machado Crossing	Road	7.5							
	Kennedy Dam	Dam	10							
	Billingmeier Rock Dam	Dam								

Information for the Stanislaus, Tuolumne, and Merced Rivers is not available. All structures are listed in order from downstream to upstream by river.

Species indicates that the species has been documented in the stream.

Up Passage indicates weather or not the species can traverse the structure in the upstream direction (yes does not indicate that passage is possible at all flows).

Down Passage indicates weather or not juvenile fishes can traverse the structure in the downstream direction.

Table 3-8. Bay Area River Matrix

River Name	Critical Habitat	Stream Type	Stream Habitat Survey Data	Stream Temperature Data	Gravel Survey Data	Vegetation Survey Data	Redd Survey Data	Steelhead Surveys Pre-1960	Steelhead Surveys 1960-1980	Steelhead Surveys 1981-2000	Salmon Surveys Pre-1960	Salmon Surveys 1960-1980	Salmon Surveys 1981-2000	Streamflow Data	Flow Adequate Steelhead	Flow Adequate Fall run	Flow Adequate Winter run	Flow Adequate Spring run	Flow Adequate Late-Fall run
Alameda Creek	Yes	Perennial	X	X					X	X	X	X	X	X	X	X			
Arroyo Del Valle	Yes	Perennial	X	X				X	X	X	X	X	X	X	X	X			
Arroyo Mocho	Yes	Perennial	X	X					X			X		X	X	X			
Calaveras Creek	Yes	Perennial	X	X				X	X	X	X	X	X	X	X				
Los Trancos Creek	Yes	Perennial	X	X				X		X	X			X	X	X			
Marsh Creek	Yes	Seasonal	X	X	X	X				X			X	X	X	X			
San Francisquito Creek	Yes	Seasonal	X			X			X	X		X	X	X					
San Lorenzo Creek	Yes	Perennial	X	X	X	X		X		X		X	X	X	X	X			
Stonybrook Creek	Yes	Seasonal																	
York Creek	Yes	Perennial	X	X					X	X				X	X	X			

Table 3-9. Bay Area Passage Matrix

River Name	Barrier Name	Description	River Mile	Sequence	PassageType	Functional Status	Enhancement	Species	Up Passage	Down Passage
Alameda Creek & Tribs	Lower Inflatable Dam	Inflatable Rubber Dam	9	1	None	None	No	Central CA Coast Steelhead	No	No
								Fall-run Chinook Salmon	Yes	Yes
	BART Weir	Weir	9.5	2	None	None	Yes	Central CA Coast Steelhead	No	Yes
								Fall-run Chinook Salmon	No	No
	Middle Inflatable Dam	Dam	9.8	3	None	None	No	Central CA Coast Steelhead	No	No
								Fall-run Chinook Salmon	No	No
	Upper Inflatable Dam	Inflatable Rubber Dam	10.5	4	None	None	No	Central CA Coast Steelhead	Yes	Yes
								Fall-run Chinook Salmon	No	No
	Niles Dam	Dam	11.9	5	Ladder, upstream	Non-operating	Yes	Central CA Coast Steelhead	No	No
								Fall-run Chinook Salmon	No	No
	USGS Gauging Station Apron	Apron	12	6	None	None	No	Fall-run Chinook Salmon	No	No
								Central CA Coast Steelhead	Yes	Yes
	Alameda Creek Road Crossing	Road	13.6	7	None		No	Fall-run Chinook Salmon	UNK	UNK
								Central CA Coast Steelhead	UNK	UNK
	Sunol Dam	Dam	16.3	8	Ladder, upstream	Non-operating	Yes	Central CA Coast Steelhead	No	No
								Fall-run Chinook Salmon	No	No
	Armored Gas Line Crossing	Pipeline	18.6	9	None		No	Central CA Coast Steelhead	No	No
								Fall-run Chinook Salmon	No	No
	Concrete swim dam #1	Dam	23.8	11	None	None	Yes	Fall-run Chinook Salmon	No	No
								Fall-run Chinook Salmon	No	No
	Concrete swim dam #2	Dam	24	12	None	None	Yes	Fall-run Chinook Salmon	No	No
								Fall-run Chinook Salmon	No	No
	Alameda Creek Diversion Dam	Dam	27.6	13	None	None	No	Central CA Coast Steelhead	No	No
								Fall-run Chinook Salmon	No	No
Arroyo Del Valle	Del Valle	Earth	11	1	None	None	No	Central CA Coast Steelhead	No	No
								Fall-run Chinook Salmon	No	No

Table 3-9 (continued). Bay Area Passage Matrix

River Name	Barrier Name	Description	River Mile	Sequence	PassageType	Functional Status	Enhancement	Species	Up Passage	Down Passage
Arroyo Mocho	Drop Structure #1	Unknown	0	1	None	None	No	Fall-run Chinook Salmon	Yes	Yes
								Central CA Coast Steelhead	Yes	Yes
	Drop Structure #2	Drop Structure	7.5	2	None	None	No	Fall-run Chinook Salmon	Yes	Yes
								Fall-run Chinook Salmon	Yes	Yes
	Road to Pumping Station	Road	12	3	None	None	No	Central CA Coast Steelhead	No	No
								Fall-run Chinook Salmon	No	No
Calaveras Creek	Calaveras	Hydraulic Fill	1	1	None	None	No	Central CA Coast Steelhead	No	No
Los Trancos Creek	Felt Lake Diversion Dam	Dam	2.5	1	Ladder	Operating	Yes		Yes	Yes
	Agosti Dam	Dam	3.3	2	None	None	No	Central CA Coast Steelhead	Yes	Yes
	Los Trancos Road Crossing	Culvert	3.5	3	None	None	No	Central CA Coast Steelhead	No	No
	Fire Road	Culvert	4	4	None	None	No	Central CA Coast Steelhead	No	No
Marsh Creek	Drop Structure	cement	4	1	None	None	No	Central CA Coast Steelhead	No	No
	Dam	Dam	11	2	None	None	No	Fall-run Chinook Salmon	No	No
San Francisquito Creek	Stanford Golf Cart Crossing	Road	7.3	1	None		No	Central CA Coast Steelhead	UNK	UNK
	Searsville Dam	Dam	12.2	2	None	None	No	Central CA Coast Steelhead	No	No
San Lorenzo Creek	Don Castro Dam	Dam			None	None	No	Central CA Coast Steelhead	No	No
	Cull Canyon Road	Road			None	None	No	Central CA Coast Steelhead	No	No
York Creek	York Dam	Dam	2.5	2	None	None	Yes	Central CA Coast Steelhead	No	Yes

All structures are listed in order from downstream to upstream by river.

Species indicates that the species has been documented in the stream.

Upstream Passage indicates weather or not the species can traverse the structure in the upstream direction (yes does not indicate that passage is possible at all flows). UNK indicates unknown.

Down Passage indicates weather or not juvenile fishes can traverse the structure in the downstream direction. UNK indicates unknown.

Other Chapters